MARTIN MARIETTA

ORNL/ER-81

ENVIRONMENTAL RESTORATION PROGRAM

White Oak Creek Embayment Site Characterization and Contaminant Screening Analysis

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ENERGY SYSTEMS
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EXECUTIVE SUMMARY

Analyses of sediment samples collected near the mouth of White Oak Creek during the summer of 1990 revealed ^{137}Cs concentrations [$> 10^6$ Bq/kg dry wt ($> 10^4$ pCi/g dry wt)] near the sediment surface. Available evidence indicates that these relatively high concentrations of ^{137}Cs now at the sediment surface were released from White Oak Dam in the mid-1950s and had accumulated at depositional sites in the embayment. These accumulated sediments are being eroded and transported downstream primarily during winter low-water levels by flood events and by a combination of normal downstream flow and the water turbulence created by the release of water from Melton Hill Dam during hydropower generation cycles. The U.S. Department of Energy and regulatory agencies were notified on September 7, 1990, of the contaminated surface sediments near the mouth of White Oak Creek. A time-critical Comprehensive Environmental Response, Compensation, and Liability Act removal action is being conducted, and a coffercell-type sediment-retention structure has been constructed at the mouth of White Oak Creek to reduce sediment erosion and to minimize the transport of radioactive sediments from the White Oak Creek Embayment (WOCE) into the Clinch River.

This report provides a more thorough characterization of the extent of contamination in WOCE than was previously available. Environmental samples collected from WOCE were analyzed for organic, inorganic, and radiological contaminants in fish, water, and sediment. These results were used to conduct a human health effects screening analysis. Walkover radiation surveys conducted inside the fenced area surrounding the WOCE at summer-pool (741 ft MSL) and at winter-pool (733 ft MSL) level, indicated a maximum exposure rate of 3 mR h^{-1} 1 m above the soil surface.

Radiological data from sediment samples were used to estimate the inventory of radionuclides contained in the embayment sediment. Cesium-137 is the dominant radionuclide and the estimated inventory ranges from 6.6 to 11.8 Ci, depending on the method of calculation. The second highest inventory is for ^{90}Sr, which has an estimated 0.2 Ci in the sediment. Several other radionuclides are present but occur in much lower quantities.

A contaminant screening analysis was conducted to determine which contaminants in the embayment might be a problem from a human health standpoint. A screening analysis using nonconservative estimates for carcinogen exposure pathways for detectable contaminants identified arsenic in water ingestion, Aroclor-1254 (polychlorinated biphenyls) in fish ingestion, and ^{60}Co and ^{137}Cs in the sediment external exposure pathway as high priority contaminants requiring immediate consideration for remedial action. Arsenic in the water ingestion pathway is a possible artifact because only 2 of the 24 water samples analyzed had concentrations above the limits of detection. Two inorganic, three organic, and four radiological contaminants had screening indexes between 10^{-6} and 10^{-4}. The screening analysis of noncarcinogens did not identify any detectable contaminants that should be assigned a high priority for consideration.

A screening analysis scenario was developed to permit a reasonable estimate of a maximum exposure to a hypothetical individual (an illegal intruder) under current conditions. Under this

scenario, an individual using the embayment frequently for fishing purposes would be exposed to $> 10^{-4}$ risk of excess cancer incidence from external exposure to ^{137}Cs in sediment and from ingestion of polychlorinated biphenyls in fish. All noncarcinogens had screening indexes of < 1.0, indicating that concentrations of noncarcinogens were below the levels of concern for a realistic maximum exposure situation.

When completed, the sediment-retention structure at the mouth of the embayment should reduce the transport of contaminated sediment into the Clinch River, maintain year-round inundation of the embayment sediments to reduce external radiation exposure, and impede the movement of fish into and out of the embayment.

1. SITE CHARACTERIZATION

1.1 INTRODUCTION

The purpose of this report is to describe the rationale and background information that have led to the proposed construction of a sediment retention structure at the mouth of White Oak Creek to prevent the erosion and transport of radioactive sediments from White Oak Creek Embayment (WOCE). This report presents the sequence of events that led to this proposed action, a general description of the area and characterization of the contaminants, and a contaminant screening assessment for the embayment.

1.1.1 Events Leading to the Interim Corrective Action

A preliminary screening analysis of the Clinch River-Watts Bar Reservoir environment by Hoffman et al. (1990) identified WOCE as an area of concern to human health because of the potential for external exposure to ^{137}Cs. The conclusion from this analysis is supported by a 1986 aerial survey that showed that the dose rate in the lower portion of WOCE from ^{137}Cs ranged from 42 to 64 μR/h (Fritzsche 1987) or about 227 to 345 mrem per year. This dose rate exceeds radiation protection standards for members of the public. Background radiation in this vicinity is about 7 to 12 μR/h.

In accordance with the Clinch River remedial investigation (RI) Phase-I sampling plan (Energy Systems 1990), a sediment core (9500G) was collected in late June 1990 from the lower portion of WOCE ~50 m upstream from the mouth of White Oak Creek. This core was analyzed for gamma-emitting radionuclides and the data became available in August 1990. The core contained ~1.7×10^6 Bq/kg dry wt (4.6×10^4 pCi/g dry wt) of ^{137}Cs in the surface sediment. The profile of ^{137}Cs concentration with depth for this core is shown in Fig. 1.1. The level of radioactivity was higher than had been anticipated and the sample was reanalyzed to verify its accuracy. Subsequently, 31 grab samples of surface sediment were collected on August 30, 1990, and analyzed for radioactivity to determine the spatial distribution of radionuclides in surface sediments in lower WOCE. Results of these analyses confirmed that relatively high levels of ^{137}Cs activity ranging from $< 1.5 \times 10^2$ to about 7.9×10^5 Bq/kg dry wt (4.0×10^0 to 2.1×10^4 pCi/g dry wt) and averaging about 4.0×10^5 Bq/kg dry wt (1×10^4 pCi/g dry wt) existed in the surface sediments at the lower end of the embayment. Using a risk factor provided by the Environmental Protection Agency (EPA) (EPA 1990), a lifetime (70-year) exposure to surface sediment containing 11 Bq/kg dry wt of ^{137}Cs would result in a 10^{-4} risk to an individual of developing excess cancer. A risk of 10^{-4} is considered an action level by EPA at Superfund sites.

In conjunction with the site characterization and risk-screening activities, an alternatives evaluation was conducted which identified a coffercell-type sediment-retention structure as an effective and environmentally appropriate method for achieving control of the contaminated sediments (U.S. Army Corps of Engineers 1991, Energy Systems 1991).

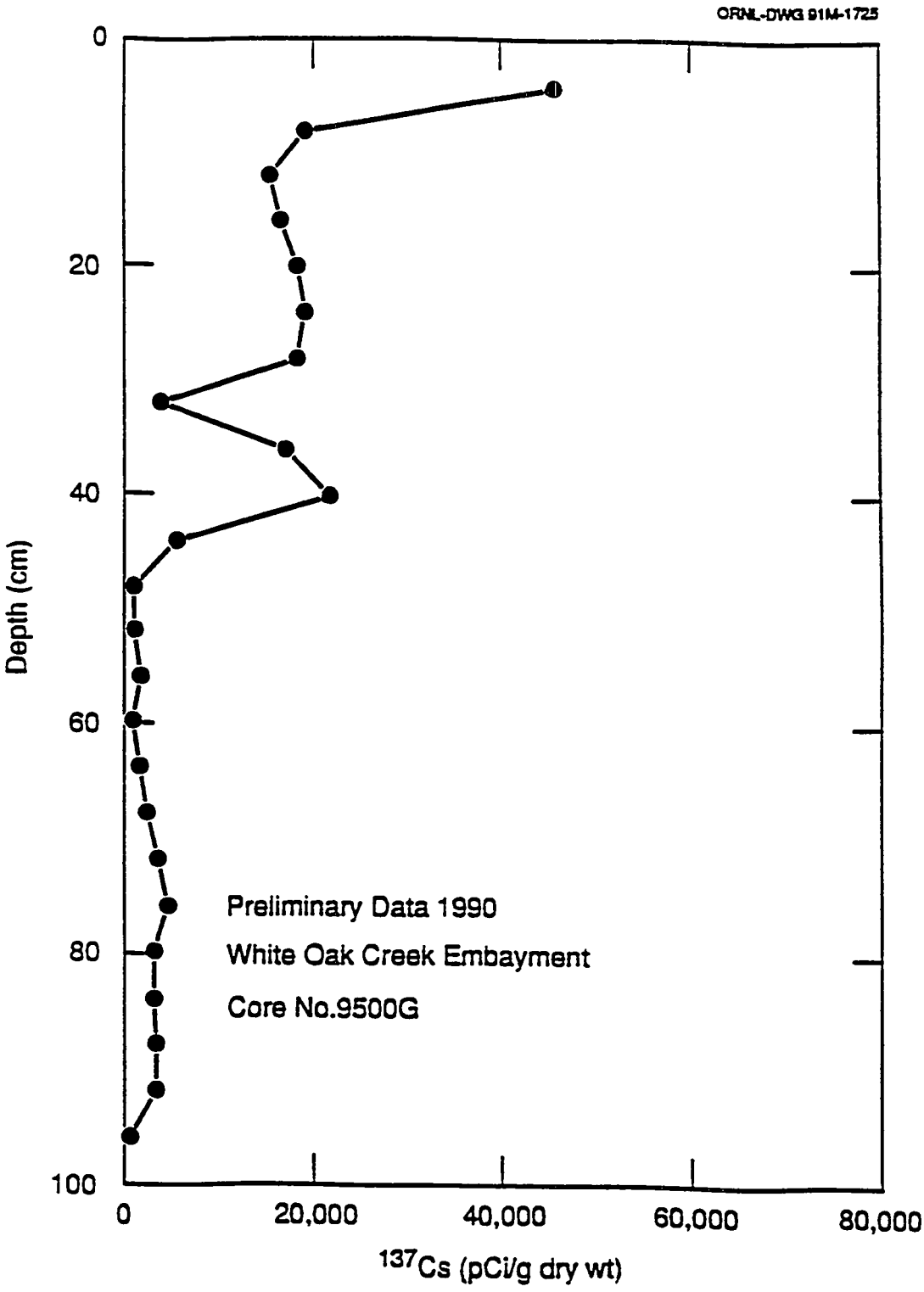


Fig. 1.1. Profile of ^{137}Cs concentrations of sediment in core no. 9500G taken ~50 m upstream from the mouth of White Oak Creek (1 pCi = 0.037 Bq).

The concentrations of ^{137}Cs found at the sediment surface produced immediate concern because surface sediments in the WOCE were not controlled (i.e., they could be readily eroded from the embayment and transported downstream into the Clinch River). On September 7, 1990, an occurrence report was filed and regulatory agencies were subsequently notified of the occurrence of contaminated surface sediments near the mouth of White Oak Creek.

1.2 DESCRIPTION OF THE AREA

1.2.1 White Oak Creek Watershed

The White Oak Creek watershed drainage area is ~16.8 km^2 (6.5 square miles) (Fig. 1.2). White Oak Creek originates on the forested slope of Chestnut Ridge and flows ~2.5 km (1.6 miles) in a southerly direction before entering the confines of the Oak Ridge National Laboratory (ORNL). Above ORNL, White Oak Creek ranges from 0.6 to 1.2 m (2.0 to 4.0 ft) in width and 10 to 25 cm (4 to 10 in) in depth and is fed by numerous springs. After the creek enters the environs of ORNL, a substantial part of the flow consists of waste water from ORNL operations. Melton Branch, which has a drainage area of ~3.8 km^2 (1.5 square miles), enters White Oak Creek at km 2.5 (mile 1.56). White Oak Dam, a small earthen dam constructed in 1943, is located on White Oak Creek 1 km (0.6 miles) upstream from the Clinch River. The portion of White Oak Creek below the dam to its mouth at Clinch River km 33.5 (mile 20.8) is known as the WOCE.

The topography of the watershed consists of parallel, northeast-southwest trending valleys and ridges formed by differential erosion of alternating weak and resistant rock strata (Edgar 1978). Four major rock formations occurring in White Oak Creek Basin (McMaster and Waller 1965) are:

- Rome formation, underlying Haw Ridge, made up of shale, siltstone, and sandstone;
- Conasauga group, underlying Melton Valley, made up of shale, siltstone, and limestone;
- Knox dolomite, underlying Chestnut Ridge and Melton Hill; and
- Chickamauga limestone, underlying Bethel Valley.

Because the Rome formation and Conasauga group underlie most of the White Oak Creek Basin, the base-flow discharge of White Oak Creek is low, and during intervals of low rainfall, no natural flow occurs. The belt of Knox dolomite underlying Chestnut Ridge forms the northwestern drainage divide and is the principal water-bearing formation.

The soils of the basin are of the red-yellow podsolic, the reddish brown laterite, and the lithosol groups. These soils are strongly leached, low in organic matter, and acidic, and they generally have exchange capacities of less than 10 meq/100 g of soil. Texture varies from silty loam to plastic clay with infiltration capacities ranging from 15 cm/h (10 in./h) to less than 0.5 cm/h (0.2 in./h) (McMaster and Waller 1965).

1.2.2 White Oak Lake Dam

In 1941, the Tennessee Valley Authority (TVA) placed a culvert and an earthen fill at White Oak Creek km 1.0 (mile 0.6) for a highway crossing. In 1943, interlocking steel piling

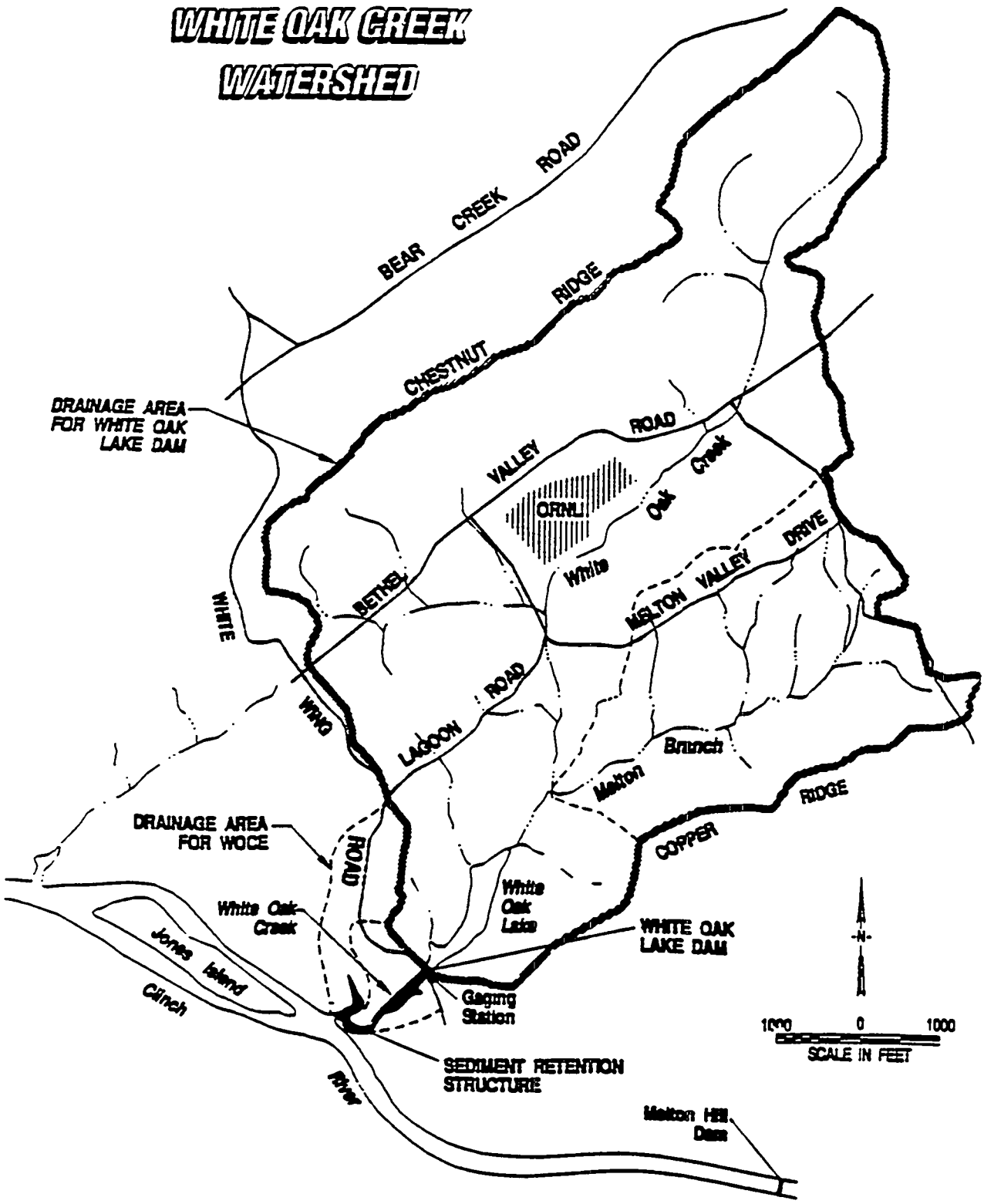


Fig. 1.2. The White Oak Creek Watershed, including the Oak Ridge National Laboratory and associated waste disposal areas. Drainage area is outlined by the broad dark lines.

and a sluice gate were placed on the upstream side of the culvert creating White Oak Lake. At the overflow elevation of 228.5 m (750 ft) MSL the impoundment was ~3.15 × 10^5 m^3 (10.5 × 10^6 ft^3) with a surface area of 17.9 ha (44.2 acres). The gate on the spillway was raised or lowered to increase the water retention time of White Oak Lake and permit the settling of suspended solids and the decay of short-lived radionuclides. Until 1949, the normal operating level of the dam ranged from 227.5 to 228.2 m (747 to 749 ft) MSL, which resulted in an impoundment of 12 to 16 ha (30 to 40 acres). At a flow rate of 7.5 cfs, the storage capacity was 23.1 d at an elevation of 228.5 m (750 ft) MSL (Setter and Kochtitzky 1950); however, periodic heavy rains could flush out the lake in a few hours.

In 1979, White Oak Lake was drawn down when an evaluation of the integrity of White Oak Dam indicated the possibility of internal erosion that could lead to subsidence (Oakes et al. 1982a, Tschantz 1987). Plans were made for improving the structure of the dam and providing a new discharge structure on the northwest side that would accommodate a 100-year flood (Oakes et al. 1982a, Boyle et al. 1982). In 1980, the dam was stabilized by adding a rock berm over a crushed rock and sand fill on the downstream side of the dam. The new discharge channel and weir system were completed in 1983.

1.2.3 White Oak Lake

White Oak Lake has served as the final settling basin for low-level radioactive effluents from ORNL since 1943. Low levels of radioactivity are released over the dam and are either deposited in the embayment sediments or transported to the Clinch River. Current levels of radioactivity that are released over the dam are much lower than in early years (Table 1.1), usually less than one Ci per year of ^{137}Cs. However, in the past, larger quantities were released. For example, after the lake was drained in 1955, ~170 Ci of ^{137}Cs (DOE 1988) were released over White Oak Dam in 1956.

In 1954, it was determined that White Oak Lake was no longer effective in terms of its ability to dilute and otherwise retain radioactive materials (Lee and Auerbach 1959). The fish population was poisoned with rotenone and removed and the lake was partially drained in October 1955, leaving a standing pond of ~2.8 ha (6.1 acres) behind the dam. The lake was drained slowly so that the contaminated silt would not be disturbed. Measurements of the radiation field above the lake bed showed that the highest dose rates were associated with former stream channels that had been filled with contaminated silt (Lee and Auerbach 1959). Flooding in 1956 and later years eroded the stream channels down to their preimpoundment depth. In 1961, an investigation was conducted to determine the extent of sediment deposition or losses from the lake bed since the draining in 1955 (Oakes et al. 1982a). By comparing measurements of the depth of sediments in 1961 with measurements made by TVA in 1953, investigators reached an estimate that ~4250 m^3 (150,000 ft^3) of silt left the lake bed because of stream channel and lake bed erosion.

From 1955 to 1969, the size of White Oak Lake varied with changes in gate elevation that gradually increased the size of the lake. In 1960, the lake area was increased to 3.2 ha (8 acres). In 1963 in response to the construction of Melton Hill Dam on the Clinch River at 37.4 km (CRM 23.4), the gate was reworked and the size of the lake was increased to 6.0 ha (15.0 acres). By 1969, the surface area of the lake was 10.5 ha (26.3 acres) (Kolehmainen and Nelson 1969), and it remained approximately this size until late November of 1979 when the elevation was reduced to 226 m (742 ft) MSL to permit improvements to

Table 1.1. Estimated discharges of selected radionuclides from White Oak Creek to the Clinch River (curies)[a]

Year	^{137}Cs	^{106}Ru	^{90}Sr	^{131}I	^{60}Co	^{3}H	TRU[b]
1949	77	110	150	77		NA[c]	0.04[d]
1950	19	23	38	19			0.04
1951	20	18	29	18			0.08
1952	10	15	72	20			0.03
1953	6	26	130	2			0.08
1954	22	11	140	4	NA		0.07
1955	63	31	93	7	7		0.25
1956	170	29	100	4	46		0.28
1957	89	60	83	1	5		0.15
1958	55	42	150	8	9		0.08
1959	76	520	60	1	77		0.68
1960	31	1900	28	5	72		0.19
1961	15	2000	22	4	31		0.07
1962	6	1400	9	0.4	14		0.06
1963	4	430	8	0.4	14		0.17
1964	6	190	7	0.3	15	1,900	0.08
1965	2	69	3	0.2	12	1,200	0.50
1966	2	29	3	0.2	7	3,100	0.16
1967	3	7	5	0.9	3	13,300	1.03
1968	1	5	3	0.3	1	9,700	0.04
1969	1	2	3	0.5	1	12,200	0.20
1970	2	1	4	0.3	1	9,500	0.40
1971	1	0.5	3	0.2	1	8,900	0.05
1972	2	0.5	6	0.3	1	10,600	0.07
1973	2	0.7	7	0.5	1	15,000	0.08
1974	1	0.2	6	0.2	0.6	8,600	0.02
1975	0.6	0.3	7	0.3	0.5	11,000	0.02
1976	0.2	0.2	5	0.03	0.9	7,400	0.01
1977	0.2	0.2	3	0.03	0.4	6,200	0.03
1978	0.3	0.2	2	0.04	0.4	6,300	0.03
1979	0.2	0.1	2.4	0.04	0.4	7,700	0.03
1980	0.6	0	1.5	0.04	0.4	4,600	0.04
1981	0.2	0.1	1.5	0.04	0.7	2,900	0.04
1982	1.5	0.2	2.7	0.06	1.0	5,400	0.03
1983	1.2	0.2	2.1	0.004	0.3	5,600	0.05
1984	0.6	0.2	2.6	0.05	0.2	6,400	0.03
1985	0.4	0.007	3.0		0.6	3,700	0.008
1986	1.0	0	1.8		0.54	2,600	0.024
1987	0.6	0	1.2		0.12	2,500	0.006
1988	0.4	0	1.1		<0.07	1,700	
1989	1.2	0	2.9		0.13	4,100	
1990	1.1	0	3.1		0.12	3,100	
Total	696.3	6,931.6	1,204.9	175.33	325.26	175,200	5.248

[a] All digits carried through to avoid rounding errors. Only first two are significant.
[b] Transuranics.
[c] "NA" means no analysis performed.
[d] Estimated from measurements made during last quarter of 1949.

the structure of the dam and construction of the new weir. A standing pond of ~5.2 ha (13 acres) (Loar et al. 1981) existed during this time. The lake is currently maintained at an elevation of 227 m (745 ft) MSL with a standing pond of ~6.9 ha (17 acres). Historical changes in the surface area of the lake and the major events associated with significant changes in the lake are summarized in Table 1.2.

1.2.4 Inventory of Radionuclides in White Oak Lake Sediments

Radioactive contamination of the sediment in White Oak Lake is well documented (Lomenick and Gardiner 1965, Oakes et al. 1982a, and Sherwood and Loar 1987). Estimates of the inventory of radionuclides in the sediment for different years are given in Table 1.3. Lomenick and Gardiner's (1965) estimate was based on the results of a comprehensive 250-core sampling program and is probably the most reliable estimate. The most recent estimate of the radionuclides in the sediment was made by Blaylock and Mohrbacher [Loar (ed) 1989].

1.2.5 White Oak Creek Embayment

WOCE is the hydrologic link between White Oak Lake Dam and the Clinch River. WOCE extends 1 km (0.6 mile) downstream from White Oak Dam and joins the Clinch River, an arm of Watts Bar Reservoir, at km 33.5 (mile 20.8) (Fig. 1.2). Water level and flow in WOCE are largely controlled by the operation of Melton Hill Dam and Watts Bar Dam. Melton Hill Dam is 4.7 km (2.6 miles) upstream of the mouth of White Oak Creek on the Clinch River. Watts Bar Dam, which forms Watts Bar Reservoir, is about 90 km (56.4 miles) downstream on the Tennessee River. The summer water elevation at the mouth of White Oak Creek at Watts Bar Reservoir is 225.8 m (741 ft) MSL. At this elevation, the depth of water at the upper end of the embayment ranges from 0.3 to 1.0 m (1 to 3 ft) and the width is ~68.5 m (225 ft). At the lower end the embayment narrows to a width of ~12m (40 ft) and the maximum depth is ~3 m (10 ft). The width at the mouth of WOCE is ~36.5 m (120 ft). The area of the embayment at the summer pool level is ~33,570 m^2 (8.5 acres). The winter elevation at the mouth of WOCE is 223 m (733 ft) MSL. At winter pool, White Oak Creek is a small stream that meanders through mud flats that are covered by water at the summer pool elevation. At the lower end of the stream, as it approaches the Clinch River, the water can reach a depth of 1 to 2 m (3 to 6 ft) in winter. During winter, the lower mud flats are covered periodically by water because of high precipitation or the operation of Melton Hill Dam.

1.2.6 Melton Hill Dam

Melton Hill Dam, located at km 37.7 (mile 23.4) on the Clinch River, is a TVA hydroelectric dam that was completed in 1963 (Fig 1.2). The electrical generating capacity of the dam is used as a peaking unit in TVA's power production grid, usually generating electricity twice a day. When the generators are operating, the release of water from the dam reverses the flow in WOCE and increases the depth of water at the mouth of the embayment by more than 2 ft within a few minutes (Fig. 1.3). When the generators stop operating, the current in WOCE reverses direction and the excess water is rapidly discharged into the Clinch River. This phenomenon increases the potential for sediment erosion in the lower portion of the embayment and sediment transport from the embayment to the Clinch River.

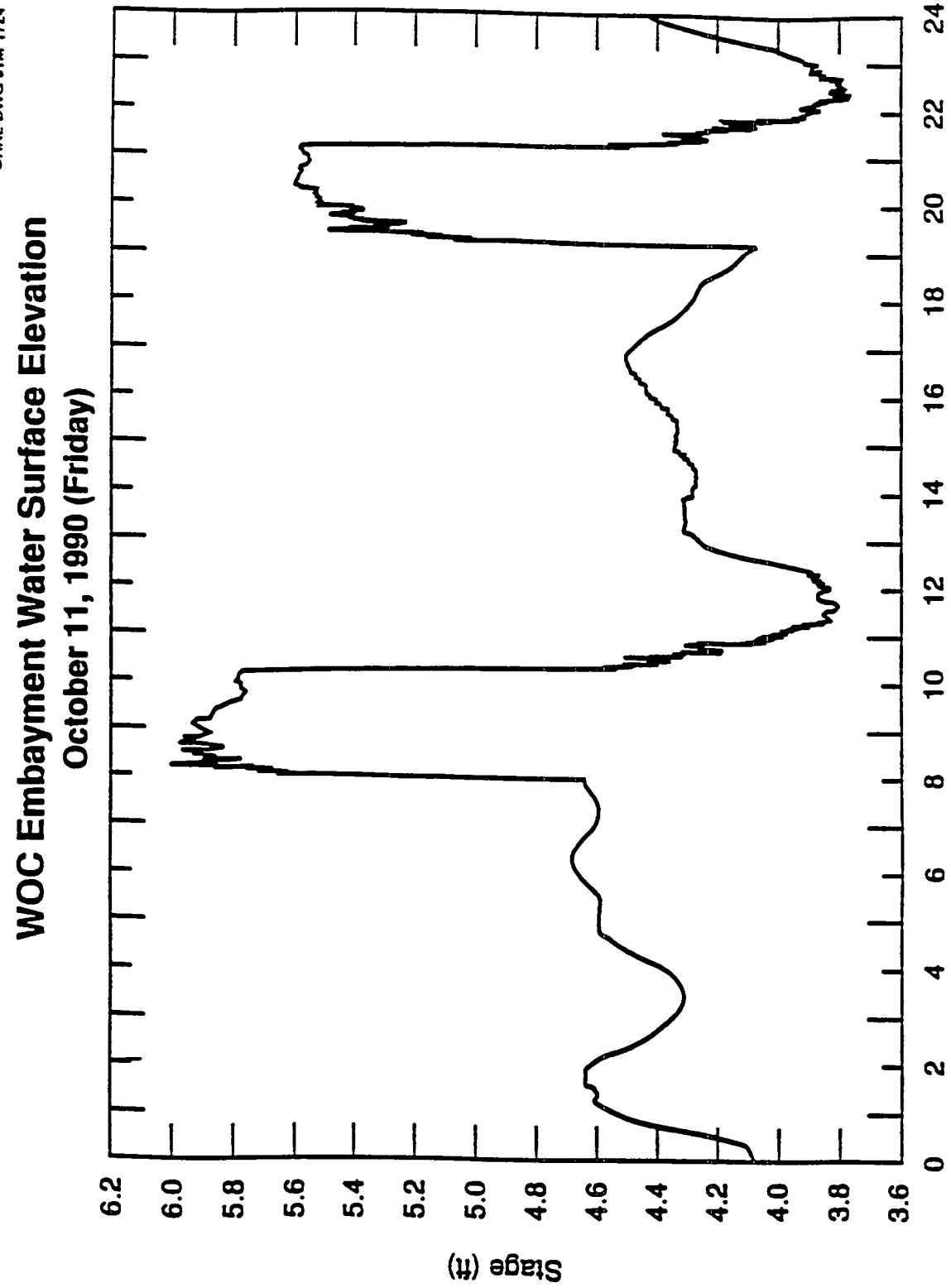


Fig. 1.3. Graph from a stage-height recorder at the mouth of White Oak Creek.

Table 1.2. Historical changes in White Oak Lake

Date	Surface area (ha)	Events	References
1941		Highway fill and culvert installed by TVA	Smith 1945 as in Krumholz 1954
1943	14.5	Sheet piling dam installed with spillway with vertical sliding gate	Krumholz 1954
1943		Generation of radioactive waste at ORNL began and lake served as final settling basin (750 ft MSL)	Morton 1961
1944	NA	Dikes at White Oak Creek km 3.3 and 3.9 washed out (7.75 in., 26 h, 3.5 in. runoff)	Setter and Kochtitzky 1950
1945	12.2	Investigation of structural strength of dam (746.5 ft)	Oakes et al. 1982a
1948	10.3	Lake lowered to 745.5 ft to facilitate sediment sampling, normal operation from 1948 to 1955 was from 747 to 749 ft	Oakes et al. 1982a
1953	NA	Lake partially drained during rotenone survey of fish population	Oakes et al. 1982a
1955	2.8	Lake drained: radionuclides in lake sediment and water believed to be in equilibrium so lake served no useful function in retaining radioactivity but could function as an emergency storage basin	Morton 1961
1956	0.4	Significant releases of ^{137}Cs probably from erosion of freshly exposed sediment after lake was drained	Lackey 1957
1959	NA	Gate structure renovated to prevent inflow of backwaters from Clinch River	Morton 1961
1960	3.2	Dam closed, surface level raised	Kolehmainen and Nelson 1969
1963	6.0	Completion of Melton Hill Dam	Kolehmainen and Nelson 1969
1967	8.1	None reported	McMaster 1967
1969	10.5	None reported	Kolehmainen and Nelson 1969
1979	4.6	Lake level gradually dropped from 745 to 742 ft because of potential instability of the dam	Oakes et al. 1982a
1980	6.9	Construction of a berm to stabilize dam was completed	Boyle et al. 1982
1983	6.9	Discharge channel and weir constructed, roadbed rerouted	Oakes et al. 1982b
1988	6.9	Estimate of surface area and volume (43,900 m^3) at lake elevation of 745 ft	Cox et al. 1991

Table 1.3. Budget of radionuclides (curies) in White Oak Lake sediment

Date	^{60}Co	^{137}Cs	^{106}Ru	^{90}Sr	TRE[a]	Total	Reference
1945						21	
1946						20	
1948						310	
1950						392	Abee 1953
1951						359	
1952						303	
1962	152	704	1038	14.6	16.6	1925	Lomenick and Gardiner 1965
1979	33	591		20		644	Oakes et al. 1982a
1989	11.4	405		17.8		434	Loar (ed) 1989

[a]Total rare earths

1.3 CONTAMINANTS IN WHITE OAK CREEK EMBAYMENT

1.3.1 Radionuclides in White Oak Creek Embayment

ORNL has hosted an array of nuclear and other research programs involving radioactive materials, such as reactor operations, fuel element reprocessing, reactor-related research, isotope production, and environmental research. Some of these activities have resulted in the release to White Oak Creek and Melton Branch of (1) primary fission products including ^{90}Sr, ^{137}Cs, and rare earth radionuclides and (2) activation products including ^{60}Co and many long-lived isotopes of transuranic elements such as plutonium. Radioactive contamination of the sediment of WOCE is well documented (Oakes et al. 1982a, TVA 1984). The dominant gamma-emitting radionuclide in WOCE is ^{137}Cs.

1.3.2 Historical Radiological Data

Sediment cores and surface grab samples have been collected from WOCE previously and analyzed for radioactivity (Cerling and Spalding 1981, Oakes et al. 1982b, and TVA 1986). The gamma-emitting radionuclides with the highest concentrations in these sediment samples were ^{137}Cs and ^{60}Co, with ^{137}Cs concentrations usually approximately an order of magnitude higher than those for ^{60}Co. In 1978, twenty four sediment cores were collected from the embayment and analyzed for radionuclides by Oakes et al. (1982b). Core no. 23, taken from the lower portion of the embayment (Fig. 1.4) contained the highest concentration of ^{137}Cs, ~3.0×10^6 Bq/kg dry wt (8.0×10^4 pCi/g dry wt) at a depth of 66 cm (26 in.), that had been reported for WOCE prior to 1990. Radionuclide concentrations measured in the sediment cores taken by Oakes et al. (1982b) are listed according to depth in Appendix A. Cesium-137 concentrations in surface grab samples taken by Cerling and Spalding (1981) in the upper portion of the embayment ranged from 3.6×10^4 to 2.0×10^5 Bq/kg dry wt (9.7×10^2 to 5.4×10^3 pCi/g dry wt) and averaged ~1.5×10^5 Bq/kg dry wt (3.9×10^3 pCi/g dry wt).

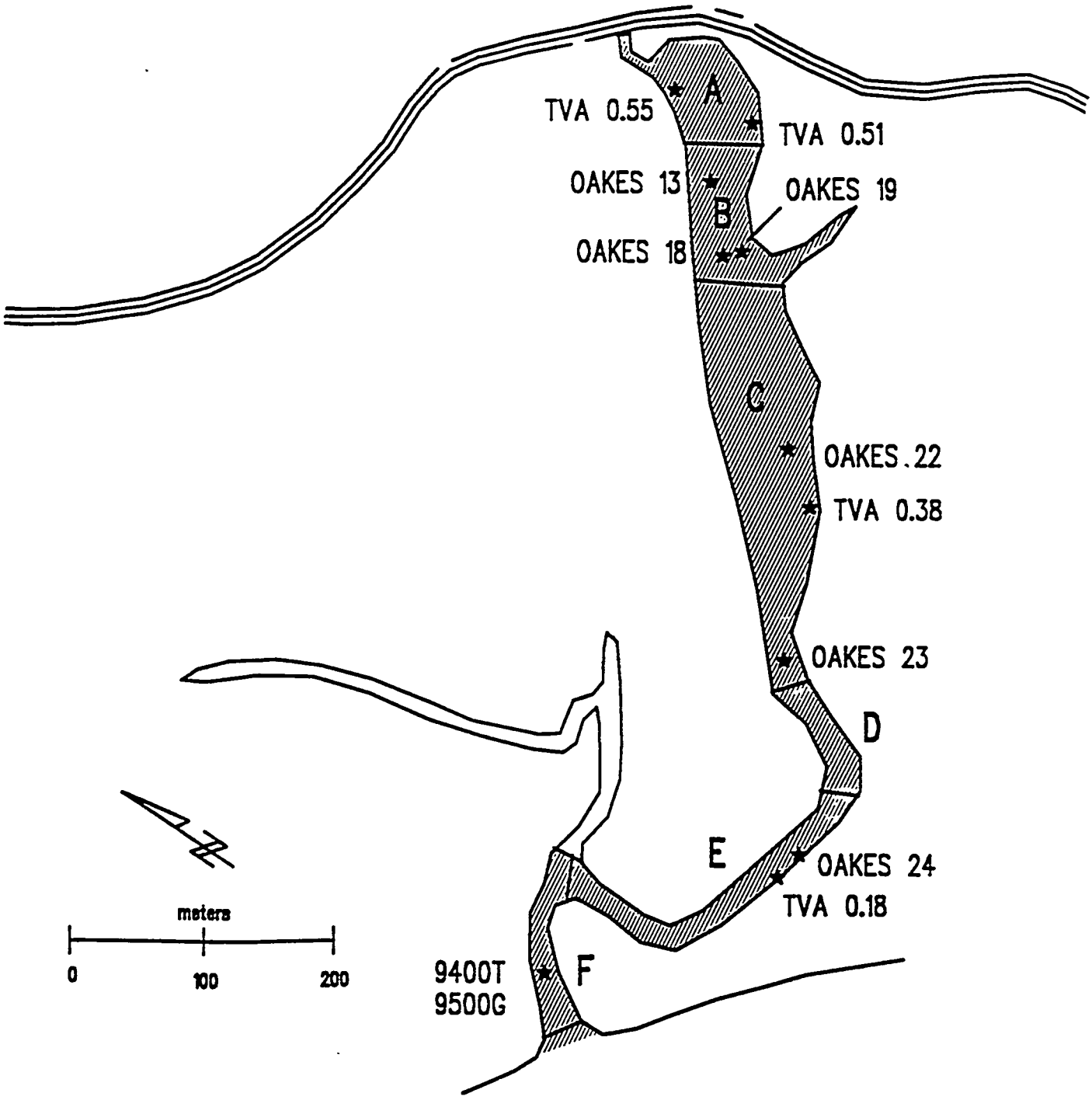


Fig. 1.4. Location of historical core sampling sites in WOCE and site of core 9500G (9500T is split of 9500G) which was collected in June 1990. The embayment was divided into six areas for the purpose of estimating inventories of radionuclides.

In 1984, four sediment cores were collected by TVA (TVA 1986) and analyzed for radioactivity and other contaminants. The cores were divided into 3- to 5-in. depth intervals for analysis of radioactivity. A sediment core collected by TVA a short distance downstream from Oakes' core no. 24 (Fig. 1.4) contained ~1.7 × 10^6 Bq/kg dry wt (4.7 × 10^4 pCi/g dry wt) of ^{137}Cs at a depth of ~25 cm. In addition to the data from these core samples, a summary of the TVA core data is given in Table 1 of Appendix B.

1.3.3 Recent Radiological Data

Sediment core 9500G, referred to previously, was taken in June 1990 as part of the Clinch River RI Phase I sampling and analyzed for radionuclides and inorganic contaminants (Energy Systems 1990). A summary of the data is given in Table 1 of Appendix C. The core was sectioned into 4-cm lengths to obtain a depth profile of the contaminants. Core 9500G was taken ~50 m upstream from the mouth of the embayment (Fig. 1.4). The surface sediments (0- to 4-cm depth) contained ~1.7 × 10^6 Bq/kg dry wt (4.6 × 10^4 pCi/g dry wt) of ^{137}Cs. A comparison of the depth profile of the concentration of ^{137}Cs in this core with previous cores collected by Oakes et al. (1982b) and TVA (1986) is shown in Fig. 1.5. The highest concentrations of ^{137}Cs detected in 1979 (Oakes et al. 1982b) and 1984 (TVA 1986) cores were 30 or more cm below the sediment surface; whereas, the core taken in June 1990 showed the highest concentration at the sediment surface. In addition, core 9500G was taken nearer the mouth of the creek and several hundred meters downstream from previous core sample sites.

After core 9500G was taken in June 1990, 31 additional sediment cores were taken in the embayment (Fig. 1.6) and analyzed for gamma-emitting radionuclides. Three transects were established across the embayment downstream from the location of core 9500G. Eight cores were taken along a transect at the mouth of the embayment. Eleven cores were taken along a transect at the mouth, and another seven along a transect ~10 m upstream from the mouth. In addition, another sediment core 10800G was taken near the site of the 9500G core and others were taken farther upstream (Fig. 1.6) for analysis of gamma emitters. Details of the procedures used for collecting and processing the sediment samples are given in the Clinch River RI Plan (Energy Systems 1990).

Depth profiles of ^{137}Cs for cores from the three transects near the mouth of the embayment are shown in Figs. D1, D2, and D3. These profiles show that the distribution of ^{137}Cs is heterogeneous with depth and that the highest concentrations are found near the middle of the channel in depositional zones. The maximum concentration of ^{137}Cs (2.2 × 10^6 Bq/kg) was detected at a depth of 22 to 24 cm in core 58400G which was taken midchannel about 10 m upstream from the mouth of the embayment (Fig. 1.6). The highest concentration of ^{60}Co (7.0 × 10^3 Bq/kg) was found in core 54400G which was taken midchannel about 10 m upstream from the mouth of the embayment. Depth profiles of cores taken adjacent to each other show the heterogenous distribution of ^{137}Cs with space as well as depth (Fig. 4 of Appendix D). Higher concentrations of ^{137}Cs and ^{60}Co could be present in the embayment, but even more intensive sampling would be required to make this determination.

Core 9500G was divided into 4-cm sections and each section was analyzed for ^{241}Am, ^{244}Cm, $^{239\text{-}240}$Pu, ^{234}U, ^{235}U, ^{238}U, and ^{90}Sr. A summary of the data for these radionuclides, including the maximum and mean concentrations, is provided in Table 3 of Appendix D. The

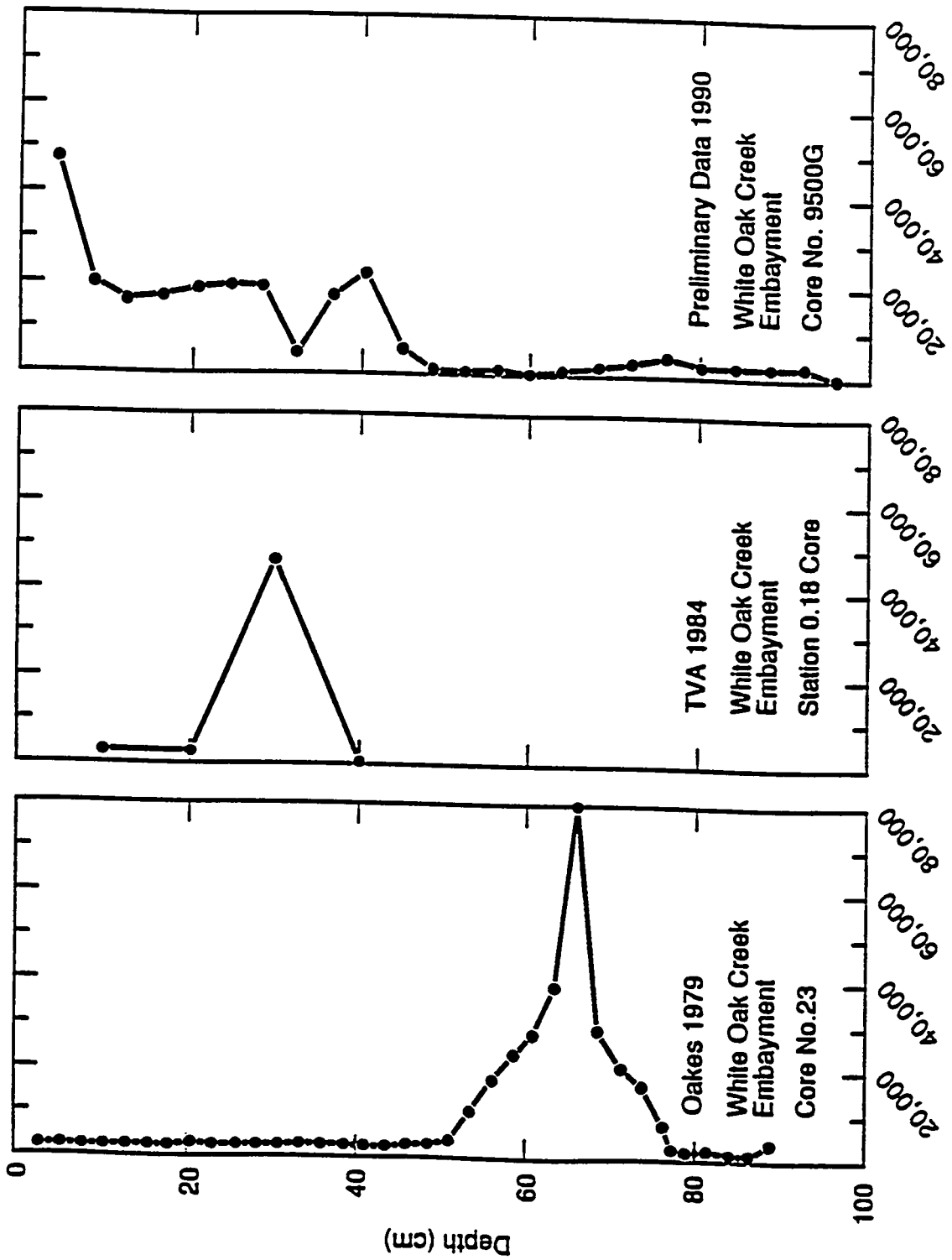


Fig. 1.5. Concentration of ^{137}Cs with depth below the sediment surface for three core samples taken in WOCE (1 pCi = 0.037 Bq).

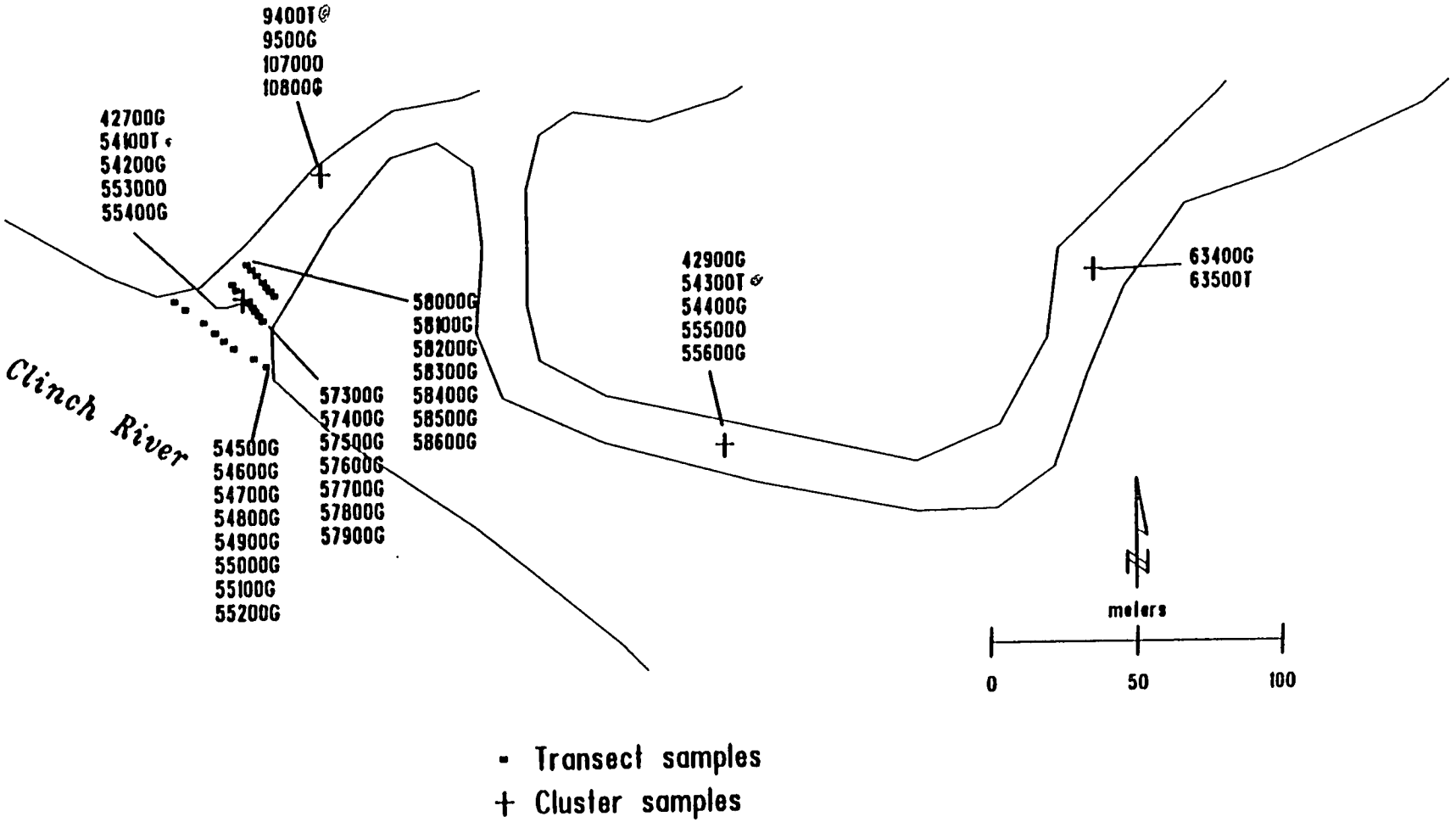


Fig. 1.6. Location of sediment core sampling sites in WOCE. Cores were taken along three transects near the mouth of the embayment where a sediment retention structure has been constructed. Clusters of cores were taken farther upstream where results from historical sampling indicated relatively high levels of radioactivity were present below the sediment surface.

mean concentrations for $^{239-240}Pu$ and ^{90}Sr in core 9500G are about an order of magnitude greater than the concentrations reported by TVA in 1986 (Table 1 of Appendix B).

To determine the spatial distribution of the surface sediment radioactivity in the embayment, 31 sediment grab samples were collected near the mouth of the embayment on August 30, 1990 (Fig. 1.7), and 41 grab samples were collected from the upper portion of the embayment on September 18, 1990 (Fig. 1.8). These samples were analyzed for gamma-emitting radioactivity and the concentrations of ^{60}Co and ^{137}Cs in these samples are given in Table D2. Concentrations of ^{60}Co in the surface sediment ranged from less than detectable to about 6×10^3 Bq/kg dry wt (1.6×10^2 pCi/g dry wt) with a mean concentration of about 9×10^2 Bq/kg dry wt (2.4×10^1 pCi/g dry wt). Concentrations of ^{137}Cs ranged from about 1.5×10^2 to 1.1×10^6 Bq/kg dry wt (4.0×10^0 to 2.9×10^4 pCi/g dry wt) with a mean concentration of ~1.0×10^5 Bq/kg dry wt (2.7×10^3 pCi/g dry wt). Although the concentrations of ^{137}Cs in the surface sediment samples did not exceed the concentrations in the 9500G core samples, results from the surface sediment analyses confirmed that relatively high levels of ^{137}Cs activity existed at the sediment surface over an area extending from the mouth to 0.25 km upstream. For example, samples 30500B and 31600B (Fig. 1.7) had ^{137}Cs concentrations of 4.4×10^5 and 7.9×10^5 Bq/kg dry wt (1.2×10^4 and 2.1×10^4 pCi/g dry wt), respectively.

1.3.3.1 Estimated Inventories of Radionuclides in Embayment Sediment

Data from 78 samples (72 plus 6 additional) of surface sediment (Appendix D) together with data from historical and recent sediment cores were used to estimate inventories for the radioactive contaminants that reside in the embayment sediment. To obtain as accurate an inventory as possible, the embayment was divided into six sections (Fig. 1.4) and an inventory was calculated for each section. Surface sediment samples were taken throughout the embayment (Figs. 1.7 and 1.8) but only historical core data were available for Sections A, B, and C. Data from recent core samples taken along transects (Fig. 1.6) showed that the contamination extended to a depth of ~1 m within the main stream channel, but outside the channel most of the contamination was in the top few centimeters of sediment (Figs. D1, D2, and D3). Therefore, an inventory was calculated for the radionuclides in the top 12 cm of embayment sediment and another for the radionuclides in the stream channel.

The radionuclide inventories for the surface sediment in Sections D, E, and F was based on the average concentration of the radionuclides in the surface samples together with the concentration in the upper 12 cm of the core samples taken in the same section. Because only historical core data were available for Sections A, B, and C, only the surface grab sample data were used to calculate the surface sediment inventory for these sections. The average surface sediment concentration (Bq/kg) for each section was multiplied by (1) the volume of sediment in the top 12 cm of each section and (2) the density of the sediment (1.3 g/cm^3) to provide an estimate of the radionuclide inventory. It was estimated that ~1.2 Ci of ^{137}Cs are present in the surface sediments of the embayment.

Data from 31 cores from Sections D, E, and F (Figs. 1.4 and 1.6) were available to estimate the inventory of radionuclides in the stream channel. The majority of these cores were taken in Section F where the coffercell-type sediment-retention structure is being constructed. Based on results of core samples taken along transects across the embayment, the width of the stream channel in Sections D, E, and F was assumed to be one-third the width of the embayment. The inventory of the stream channel was estimated by using the

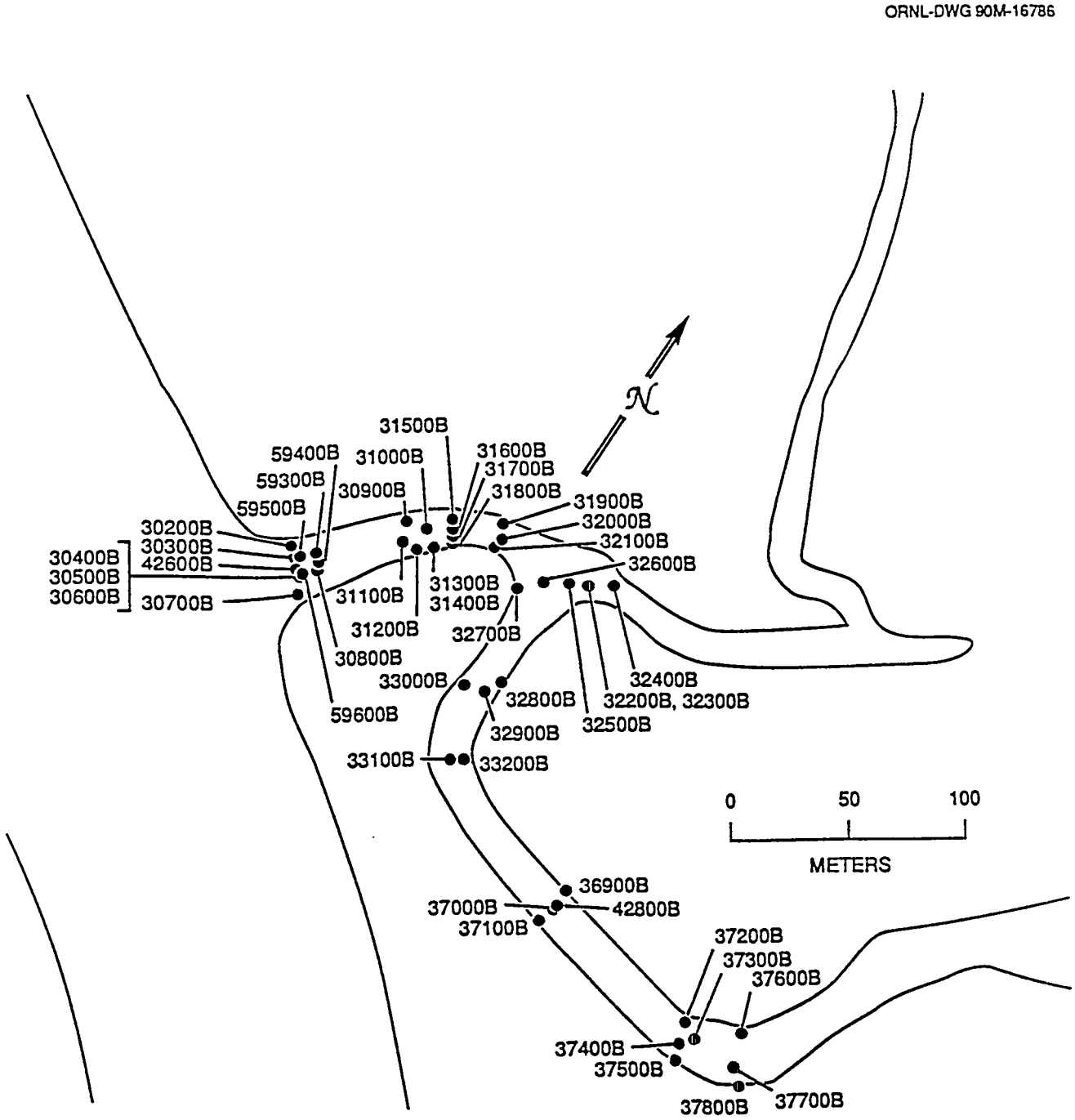


Fig. 1.7. Locations where surface sediment grab samples were collected in 1990 and 1991 from the lower end of WOCE.

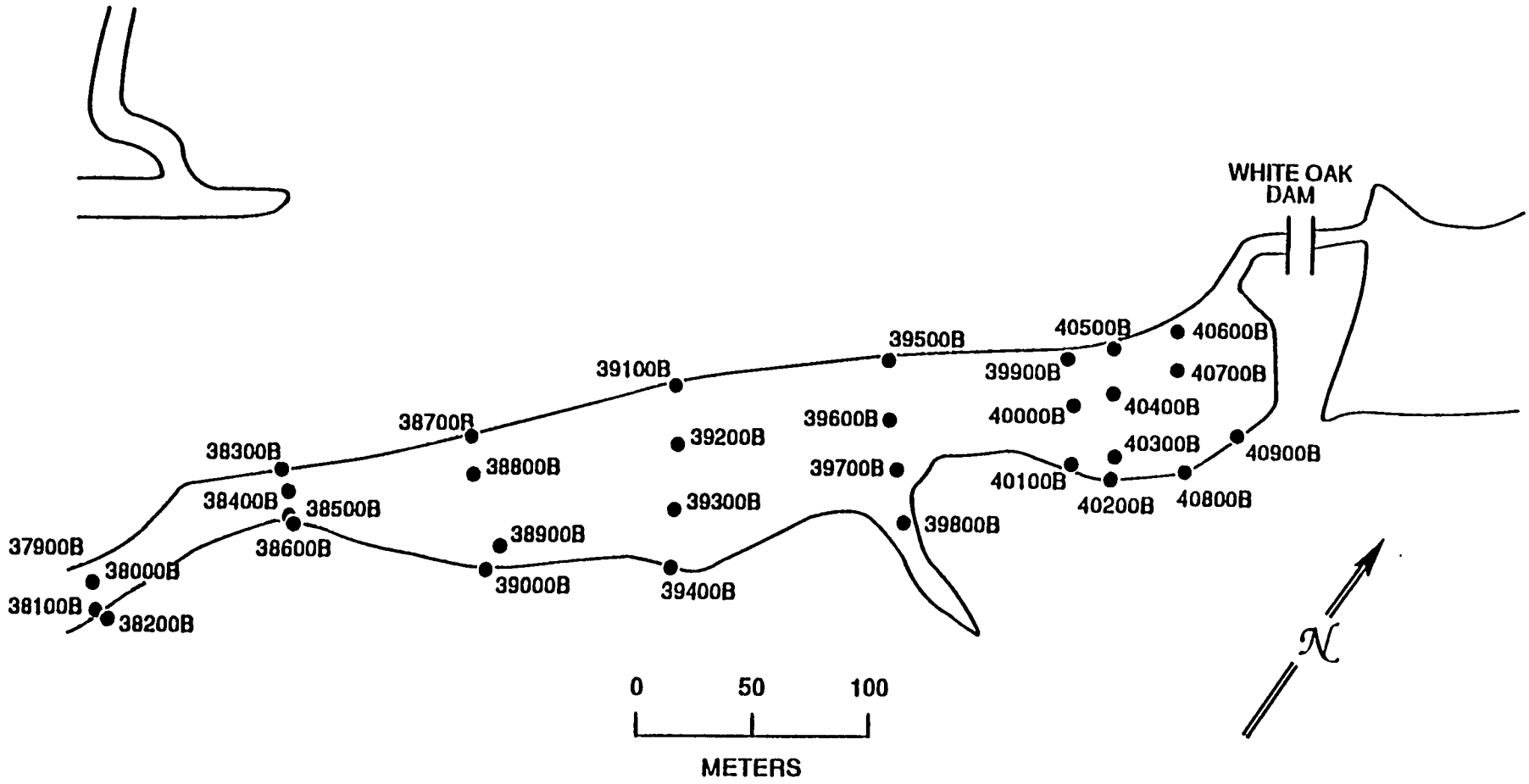


Fig. 1.8. Locations where surface sediment grab samples were collected in 1990 and 1991 from the upper end of WOCE.

diameter of the cores to calculate the concentration of the radionuclides on an area basis and then obtaining the mean concentration per m^2 for each section. Using this procedure, an estimate of 4.5 Ci of ^{137}Cs was obtained for the stream channel in Sections D, E, and F. Using the same procedure but substituting the concentration per m^2 for ^{137}Cs in core 9500G for the average concentration yields a stream channel inventory of 9.7 Ci of ^{137}Cs for these sections.

Because the core data for Sections A, B, and C were historical and limited, the radionuclide inventory for the upper sections of the stream channel was based on the concentration (Bq/kg) of the radionuclides in the sediment following the procedure used for the surface samples. The area of the stream channel in Sections A, B, and C was based on the width of the stream at the winter pool level (733 ft MSL). The estimated inventory of ^{137}Cs for the stream channel in Sections A, B, and C is 1.7 Ci. If the inventory of ^{137}Cs in the surface sediment is combined with the inventory for the entire stream channel based on average concentrations, the total ^{137}Cs inventory for the embayment sediment is 6.6 Ci; however, using the inventory value for the stream channel in Sections D, E, and F based on the concentration per m^2 in core 9500G would result in an estimate of 11.8 Ci of ^{137}Cs in the sediment.

Using the same methods described above, the estimated inventory for ^{60}Co in the embayment ranges from 0.06 Ci using mean values to 0.09 Ci using the value from core 9500G. Inventories for other radionuclides in the sediment are based on data from core 9500G and historical data from cores taken several years earlier (Table 1 of Appendix B). Estimated inventories for radionuclides in the embayment sediment are given in Table 1.4.

Considerable uncertainty is associated with estimating the inventory of radionuclides in the sediment of the embayment because of the heterogeneous distribution of the radionuclides. The uncertainty of the estimates is also compounded by the fact that a limited number of core samples from the upper section of the embayment were available for analysis and that few samples were analyzed for ^{90}Sr and transuranic radionuclides. The uncertainty associated with the estimated inventories for Sections A, B, and C could be reduced by collecting additional cores along the stream channel in these sections. A "walk over" radiation survey (Sect. 1.3.9) revealed a relatively high external exposure rate (3 mR h^{-1}) at one location along the stream channel in Section A which suggests that the inventory of ^{137}Cs for this section may be underestimated. Greatest confidence can be placed on the estimated ^{137}Cs and ^{60}Co inventories for Section F where the largest number of cores were collected.

1.3.4 Organic Contaminants in White Oak Creek Embayment Sediments

Data for organic and inorganic contaminants in WOCE are more limited than data for radionuclides. Analyses for polychlorinated biphenyls (PCBs) in White Oak Lake, White Oak Creek above the lake, and Melton Branch clearly indicate that the White Oak Creek system is contaminated with PCBs (Boyle et al. 1982). An average concentration of 0.5 μg/g dry wt of PCBs was detected in WOCE sediment during monitoring in 1974–1975 (ERDA 1975). In 1984, TVA sampled sediments in WOCE as part of the Oak Ridge Task Force Study (TVA 1985a,b). PCBs were not detected in samples from three of four cores; however, TVA core White Oak Creek 0.18 (Fig. 1.4) contained 2.8 μg/g dry wt of PCBs (TVA 1985a,b). In addition to PCB analyses, composite samples from the sediment cores collected by TVA were analyzed for 43 other organic contaminants (Appendix B). Concentrations of all of these contaminants were less than detectable except for bis (2-ethylhexyl) phthalate, which was detected at a concentration of 1.6 μg/g dry wt in TVA core White Oak Creek 0.55 (Fig. 1.4).

Table 1.4. Estimated inventory of various radionuclides in WOCE sediments

Radionuclide	Total Ci[a] (mean)	Total Ci[a] (maximum)	Percent of total activity
Cs-137	6.6	(11.8)	95
Co-60	0.06	(0.09)	1
Sr-90[b]	0.2		3
Am-241[b]	0.009		0
Cm-244[b]	0.001		0
Pu-238[b]	0.002		0
Pu-239, 240[b]	0.056		1
U-234[b]	0.005		0
U-235[b]	0.005		0
U-238[b]	0.003		0
Total activity	6.9		

[a]Method of calculation described in the text.
[b]Inventory based on results from core 9500G and historical data.

Sediment core 10700O (a split of 10800G) (Fig. 1.6), collected as part of the Clinch River RI Phase I sampling (Energy Systems 1990), was analyzed for inorganic and organic contaminants. The cores were sectioned into 4-cm lengths, and each section was analyzed to determine the concentration of pollutants with depth. The samples were analyzed for a total of 85 organic contaminants including PCBs. Of these contaminants, only PCBs and diethylphthlate were above the limits of detection for the analytical methods used. A summary of the data showing the mean values and ranges is given in Appendix C.

Two additional sediment cores (55300O and 55500O, splits of 55400G and 55600G, respectively) were collected in January 1991 from different sections of WOCE (Fig. 1.6) and analyzed for organic contaminants. These cores were sectioned into 4-cm lengths and each section was analyzed for 91 organic contaminants. Only five contaminants were above the limits of detection: Aroclor-1260, bis (2-ethylhexyl) phthalate, fluoranthene, phenanthrene, and pyrene. Although these organic compounds were detected, the reported values are estimates because the concentrations were less than the contract-required quantitation limits. A summary of the data for these cores is provided in Table 2 of Appendix C.

1.3.5 Inorganic Contaminants in White Oak Creek Embayment Sediments

Composite samples from four sediment cores collected by TVA in 1984 (TVA 1986) were analyzed for metals by available inductively coupled plasma and absorption spectrometry methodologies. A summary of these data is given in Appendix B. Metals having the highest mean concentrations in the cores were chromium, lead, nickel, and zirconium. Mercury had a mean concentration in sediment of 3.4 ± 1.7 mg/kg dry wt and a maximum value of

6.0 mg/kg; arsenic had a mean concentration of 8.3 ± 3.8 mg/kg dry wt and a maximum value of 12.0 mg/kg dry wt.

A summary of the data from sediment core 9400T (a split of 9500G) is given in Appendix C. Metals having the highest mean concentrations in this sediment core were zinc, mercury, lead, chromium, copper, and nickel, respectively. The mean concentrations of metals in core 9400T were much higher than the mean concentrations in the four TVA cores, except for arsenic, which was lower. The mean concentration for arsenic was 4.0 ± 1.7 mg/kg dry wt with a maximum value of 7.6 mg/kg dry wt. Concentrations of mercury and lead were greater than 100 mg/kg dry wt in the top four cm of core 9400T. The concentration of mercury in core 9400T is relatively high in comparison to most other metals detected in the core sample. The highest concentration (360 mg/kg dry wt) occurred at a depth of 36 cm (Fig. 1.9). Because of the limited number of metal analyses, the variability observed in the concentrations, and the high concentrations observed in core 9400T, it was determined that additional samples were needed.

Three additional sediment cores (54100T, 54300T, and 63500T) collected from different locations in WOCE (Fig. 1.5) after July 1990 were analyzed for inorganic contaminants. Methods used to analyze these cores were similar to those used for core 9400T. In most instances, the mean and maximum values for inorganics reported for core 9400T are greater than the values reported for the three additional cores (Tables 1 and 2 of Appendix C). An exception to this observation is arsenic, which showed a maximum of 17.4 mg/kg and a mean of 4.6 ± 2.7 mg/kg, values that are slightly higher than previously reported. The mean value for lead in core 9400T was much higher (66.1 mg/kg dry wt) than the mean in the three additional cores (34.9 mg/kg dry wt). The maximum value (156 mg/kg dry wt) for lead occurred at a depth of 12 to 16 cm in core 54300T. Profiles of the distribution of arsenic, lead, and mercury with sediment depth for cores 9400T, 54100T, and 54300T are shown in Fig. 1.9.

Mean sediment values for zinc were the same for core 9400T and the other cores (Tables C1 and C2). A maximum concentration of 403 mg/kg was found at a depth of 100 to 104 cm in core 54300T. Because this value is about a factor of 4 higher than the maxima for the other cores, the maximum value is possibly an artifact. Concentrations of mercury in core 9400T are unusually high in comparison to the concentrations found in the other three cores. The mean mercury concentration for core 9400T is more than an order of magnitude greater than the mean values for the other cores (Tables C1 and C2) and the maximum is about a factor of 6 greater. The high value for core 9400T appears to be an isolated deposit of mercury. An estimate of the average concentration of mercury in the embayment sediment based on data from the three cores (54100T, 54300T, and 63500T) would be much lower than an estimate based on the mercury concentration reported for core 9400T.

1.3.6 Classification of Potential Waste from White Oak Creek Embayment Sediments

The discovery of elevated levels of radionuclides and inorganic contaminants (using conventional analytical techniques) in WOCE complicated the waste classification of the sediment. Sediment waste from the construction of the sediment retention structure must be categorized, for waste management and health and safety concerns, as either low-level radioactive waste (LLW) or mixed waste (containing LLW and inorganic contaminants). A designation of the embayment sediment as mixed waste would present difficulties in managing waste generated by construction activities. The Toxicity Characteristic Leachate Procedure

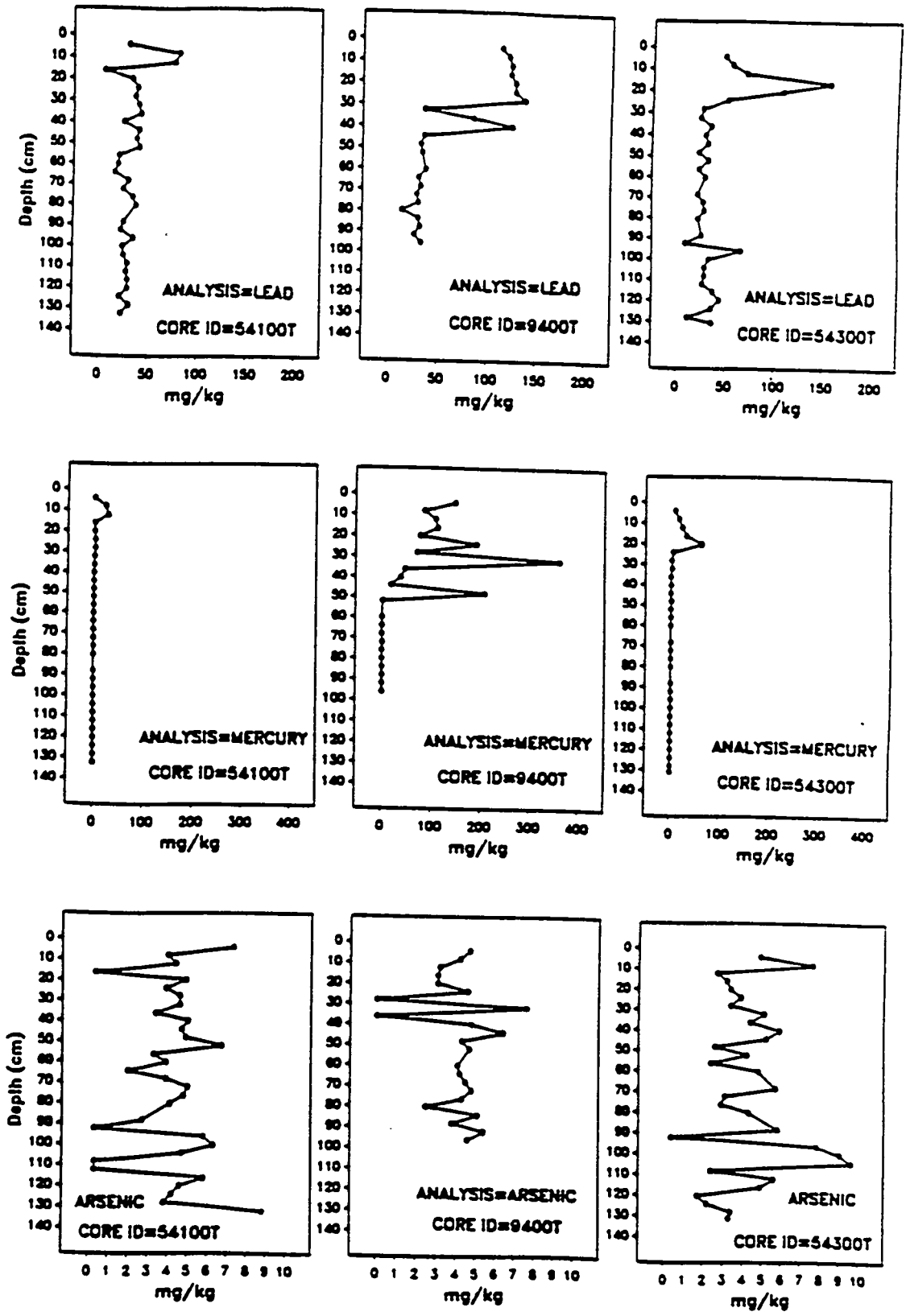


Fig. 1.9. Profiles of the distribution of arsenic, lead, and mercury by depth in three sediment cores.

(TCLP) is mandated by EPA as a method for waste characterization (*Federal Register*, 1990a, 1990b). Samples were screened by conventional analytical procedures prior to submittal for TCLP analysis. If the concentration of a contaminant in a sample was close to or above the guidance level for solid materials given in the *Federal Register* (1990b), the TCLP was performed. Results from the TCLP analyses showed that the embayment sediments do not fall into the category of mixed waste. A more detailed discussion of the TCLP, analytical results, and sample locations is given in Appendix M.

1.3.7 Water Analyses

A National Pollutant Discharge Elimination System and radiological monitoring station has been located at White Oak Dam for many years. Water samples are analyzed for anions, metals, organics (chloroform, total PCBs, and trichloroethylene), radionuclides (gross beta, gross alpha, total strontium, and seven specific radionuclides), and water quality parameters. A summary of the data collected from January 1989 to September 1990 is given in Table 1 of Appendix E. The concentration of tritium was higher than that of any of the other radionuclides analyzed in the water samples at White Oak Dam, reaching a maximum concentration of 1.6×10^4 Bq/L (4.3×10^2 pCi/mL).

A Clinch River RI water sample was collected ~50 m upstream from the mouth of White Oak Creek in February 1990 and analyzed for organics, metals, and radionuclides. The results of these analyses are summarized in Table 1 of Appendix F. Total and dissolved metal concentrations were determined. Concentrations of all organics for which analyses were conducted were less than detection limits. Of the 13 metals for which analyses were conducted, only zinc and chromium were above the limits of detection; zinc had the higher concentration. Tritium and ^{90}Sr were the most abundant radionuclides in the water with approximate concentrations of 1×10^4 and 8×10^0 Bq/L (3×10^2 and 2×10^{-1} pCi/mL), respectively. Concentrations are considered approximate and of limited use because of incorrect preservation of the samples before analysis; therefore, they should not be used outside of this report. The Clinch River RI values are, however, well within the range of observed concentrations from ORNL radiological monitoring activities.

1.3.8 Aquatic Biota in White Oak Creek Embayment

Sampling of biota in the WOCE for radiological and chemical analyses has focused primarily on fish; however, biota in White Oak Lake have been more intensively sampled, and invertebrates, aquatic macrophytes, turtles, waterfowl, and fish have been analyzed. Most analyses in the past were for radionuclides, but recently more emphasis has been placed on PCBs, mercury, and other metals. In general, the concentration of contaminants in biota in White Oak Lake is greater than in biota in WOCE because of the higher environmental concentrations of contaminants in the lake; however, PCBs are an exception [Loar (ed) 1989]. Previous analyses of fish from WOCE have shown that the primary contaminants above background levels are PCBs, chlordane, mercury, ^{60}Co, ^{137}Cs, and ^{90}Sr [Loar (ed) 1989, 1990].

Three species of fish from WOCE were analyzed for either organics, metals, or radionuclides following guidelines found in the Clinch River RI Phase I sampling plan (Energy Systems 1990). These data are summarized in Table 1 of Appendix G. Bluegill (*Lepomis macrochirus*) were analyzed for metals and ^{137}Cs. Catfish (*Ictalurus punctatus*) were analyzed for organics, including PCBs, and for ^{60}Co, ^{137}Cs, ^{90}Sr, and ^{235}U. Largemouth bass (*Micropterus salmoides*) were analyzed for a selected list of contaminants including metals and

^{137}Cs. Bluegill have a small home range and usually remain in the same area; therefore, they are considered good indicators of contaminants in a particular stretch of a stream. Catfish are benthic feeders, have a high lipid content, tend to accumulate PCBs and other organic contaminants, and should contain the highest concentration of organic contaminants. Largemouth bass represent top predators in the food chain and should serve as indicators of contaminants that accumulate through the food chain. Additionally, these three species are commonly consumed by the general public and are representative of different trophic levels.

Six to ten individuals of each species were analyzed for the various contaminants; however, for some organic contaminants only two largemouth bass were analyzed. Concentrations of the primary contaminants (PCBs, mercury, arsenic, ^{137}Cs, and ^{90}Sr) in these samples were similar to those reported previously [Loar (ed) 1989, 1990].

1.3.9 External Radiation Survey

A walkover gamma radiation survey was conducted inside the fenced area surrounding WOCE in October and November 1990 by the Measurement Applications and Development group of the Health and Safety Research Division (Patania 1991a). This survey was designed to provide a rapid estimate of the extent of surface contamination by measuring the radiation emitted by gamma-emitting radionuclides. During this survey, the water was at summer-pool level (741 ft MSL) and the upper end of the embayment was covered with water.

A second survey began in February 1991 (Patania 1991b) to determine the radiation exposure rates associated with the embayment at the winter-pool level (733 ft MSL) when much of the embayment sediment is exposed. Unfortunately, this low-water survey had to be terminated at the end of March 1991 as a result of weather conditions and increasing water levels. Consequently, only the upper two-thirds of the north side of the embayment was surveyed at the winter-pool level.

The survey technique consisted of a gamma radiation survey at 1 m above the soil surface with hand-held gamma scintillometers over the entire accessible area on both banks of the embayment. A pressurized ionization chamber was used to quantify the exposure rate indicated by the scintillometers. No ground-level contamination survey was conducted, nor were sediment samples taken for analysis in conjunction with the surveys.

The gamma survey conducted when the water was at the summer pool level indicated elevated exposure rates throughout ~80% of the length of the embayment, restricted primarily to the shorelines and other low-lying areas where sediment deposition by embayment water is likely. The exposure rates ranged from 19.0 to 318 μR/h, and a general pattern of exposure is shown in Fig. 1.10. A 1-year continuous exposure at 318 μR/h is approximately equivalent to a 2×10^{-3} lifetime risk of excess cancer incidence (using a risk coefficient of 7.2×10^{-4} per rem). Natural background in the vicinity of the embayment ranged from 7.0 to 12.0 μR/h. A 1-year exposure at the background rate is approximately equivalent to a lifetime risk of excess cancer incidence of 4×10^{-5} to 1×10^{-4}. The highest exposure rate of 318 μR/h was located at a spot on the north bank of the embayment in the vicinity of the area where the higher levels of ^{137}Cs were found in sediment cores by Oakes et al. (1982b) and TVA (1984) (Fig 1.4). Levels of exposure at the mouth of the embayment and adjacent banks of the Clinch River both upstream and downstream ranged from 11 to 107 μR/h.

The exposure rates at the winter pool level ranged from 47 to 3000 μR/h and were highest near the stream channel. A general pattern of exposure rates for the area on the north side

of the embayment that is above the summer water level is shown in Fig. 1.11. At the winter pool level, when more of the embayment sediment is exposed, the exposure rate at the security fence on the north side reaches 60 μR/h (Fig. 1.11); whereas, at the summer-pool level, the exposure rate at the same location is <25 μR/h (Fig. 1.10). The higher exposure rate at the winter pool level results from the gamma radiation coming from the exposed bottom sediments in the floodplain.

A pattern of exposure rates for the north side of the exposed floodplain at winter pool level is shown in Fig. 1.12. Exposure rates ranged from 200 to 3000 μR/h near the stream channel for the portion of the floodplain that was surveyed. The highest exposure rates (1500 to 3000 μR/h) occurred in a small area along the stream channel about 100 m downstream from White Oak Dam and Highway 95 (Fig. 1.12). A one-year continuous exposure at 3,000 μR/h is approximately equivalent to a 1.9×10^{-2} lifetime risk of excess cancer incidence. Concentrations of ^{137}Cs in surface sediment grab samples (40100B, 40100B, and 40300B) from this area ranged from 4×10^4 to 8.5×10^4 Bq/kg dry weight. A sediment core is needed from this area to determine the distribution of gamma-emitting radionuclides with depth. The area of the embayment south of the stream channel was not surveyed for gamma radiation because of rising water levels.

1.3.10 Source of ^{137}Cs in White Oak Creek Embayment Sediments

Cesium-137 released over White Oak Dam either in solution or associated with suspended solids is the primary source of ^{137}Cs in WOCE sediments. When released over White Oak Dam, ^{137}Cs is either deposited in the sediment of WOCE or transported into the Clinch River. The relatively high concentration of ^{137}Cs found at a depth of 63 cm in core no. 23 taken in 1979 (Oakes et al. 1982b) and at a depth of 25 cm in TVA core 0.18 (TVA 1984) (Fig. 1.5) suggests that these concentrations represent past releases. The relatively high concentrations of ^{137}Cs observed at the sediment surface in core 9500G taken June 1990 as part of the Clinch River RI Phase-1 sampling (Fig. 1.6) and in the surface sediment grab samples taken near the mouth of White Oak Creek (Fig. 1.7) suggest either that relatively high levels of ^{137}Cs have been released over White Oak Dam in recent years or that sediments deposited in previous years have been redistributed. Annual release records of ^{137}Cs at White Oak Dam (Table 1.1) and recent monitoring data (Table E1) indicate that recent releases are unlikely to be responsible for the concentrations in the surface sediments at the mouth of White Oak Creek. In addition, it is unlikely that resuspension of White Oak Lake sediments during storm events is the source of the ^{137}Cs, because the current concentration of ^{137}Cs in surface sediments in White Oak Lake ranges from 1×10^5 to 2×10^5 Bq/kg dry wt (3×10^3 to 5×10^3 pCi/g dry wt) [Loar (ed) 1989]. Data in Table 1.1 show that most of the ^{137}Cs was released from White Oak Lake from 1954 to 1957. The greatest release (170 Ci) occurred in 1956 as a result of flooding that scoured highly contaminated sediment from the lake bed after White Oak Lake was drained in 1955.

All evidence supports the conclusion that relatively high concentrations of ^{137}Cs in the surface sediment near the mouth of WOCE are from past releases. Some of the highly contaminated sediment from White Oak Lake was deposited in depositional zones of WOCE where it continued to be covered by less contaminated sediment. Normal erosion processes, especially during storm events, undoubtedly resulted in the redistribution and downstream transport of embayment sediment. When Melton Hill Dam became operational in 1963, fluctuating water levels and flow reversals (Fig. 1.3) associated with power generation resulted in daily flooding and draining of mud flats during winter pool conditions and likely contributed to the erosion and redistribution of sediments in the embayment.

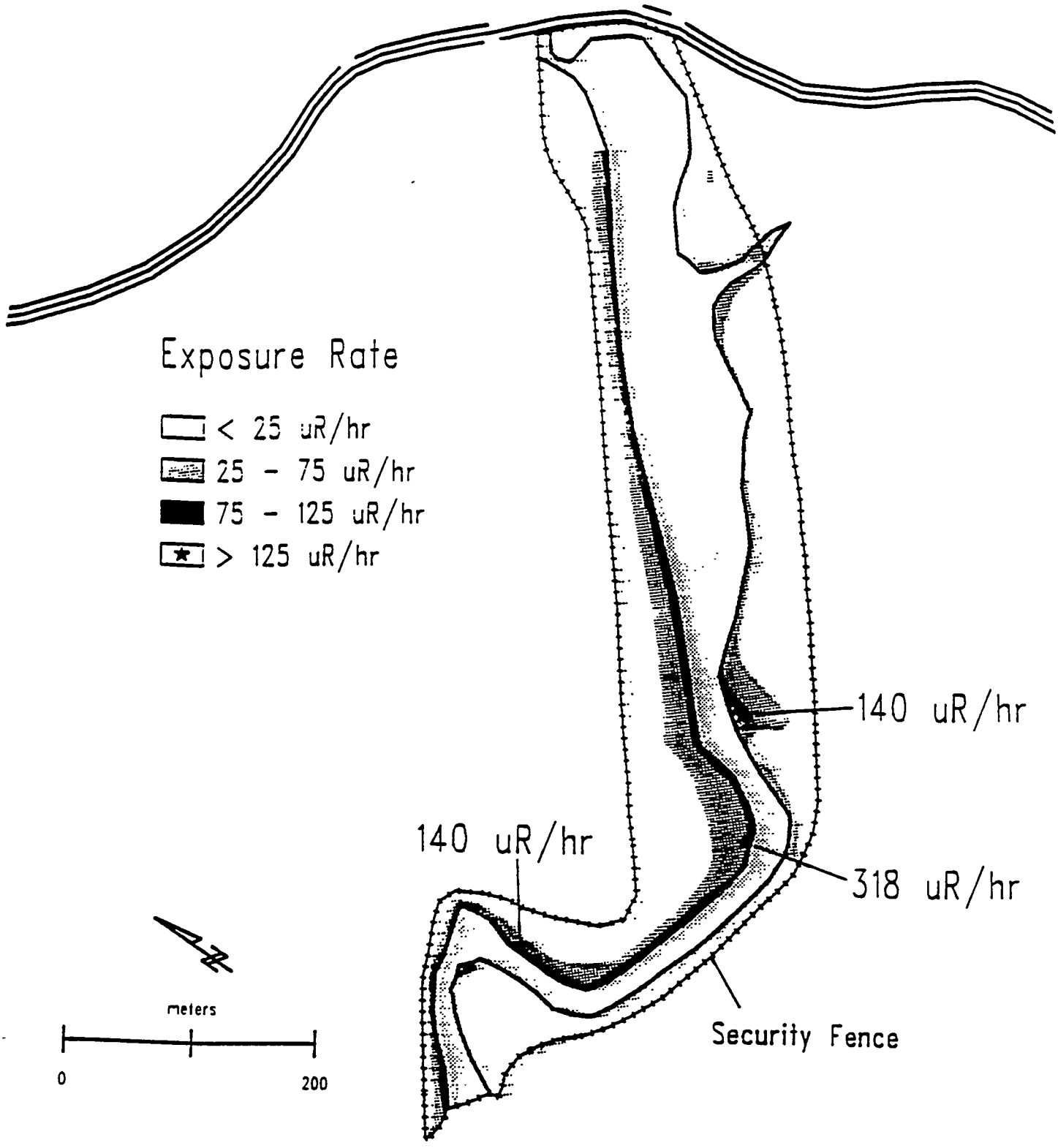


Fig. 1.10 Survey of gamma (primarily ^{137}Cs) radiation exposure rates measured 1 m above the ground surface along the banks of WOCE when water was at full-pool level.

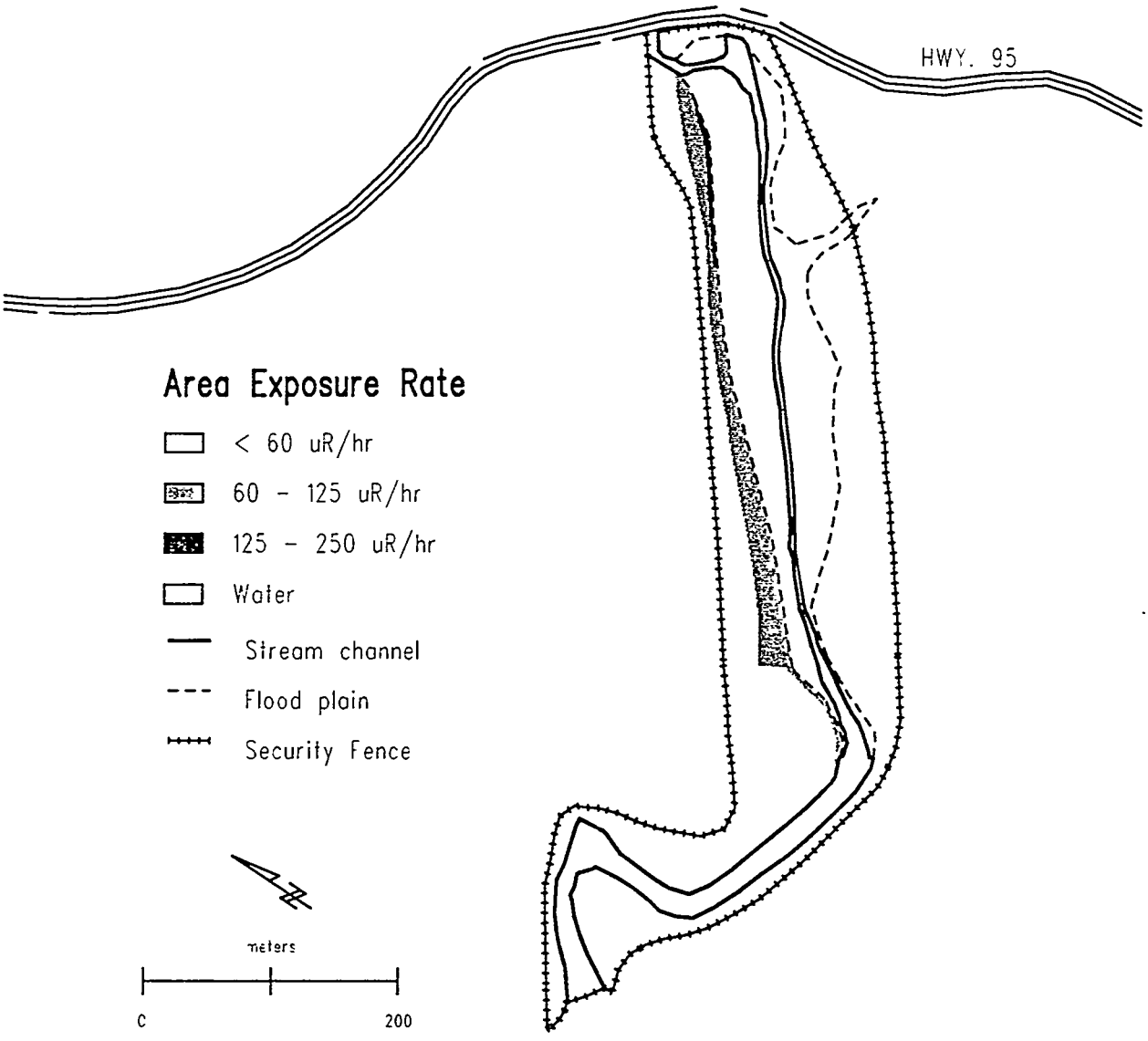


Fig. 1.11. Survey of gamma (primarily ^{137}Cs) radiation exposure rates measured 1 meter above the ground surface when the water was at low-pool level. The shaded areas show the exposure rates on the north side from the personnel fence to the water line at full-pool level.

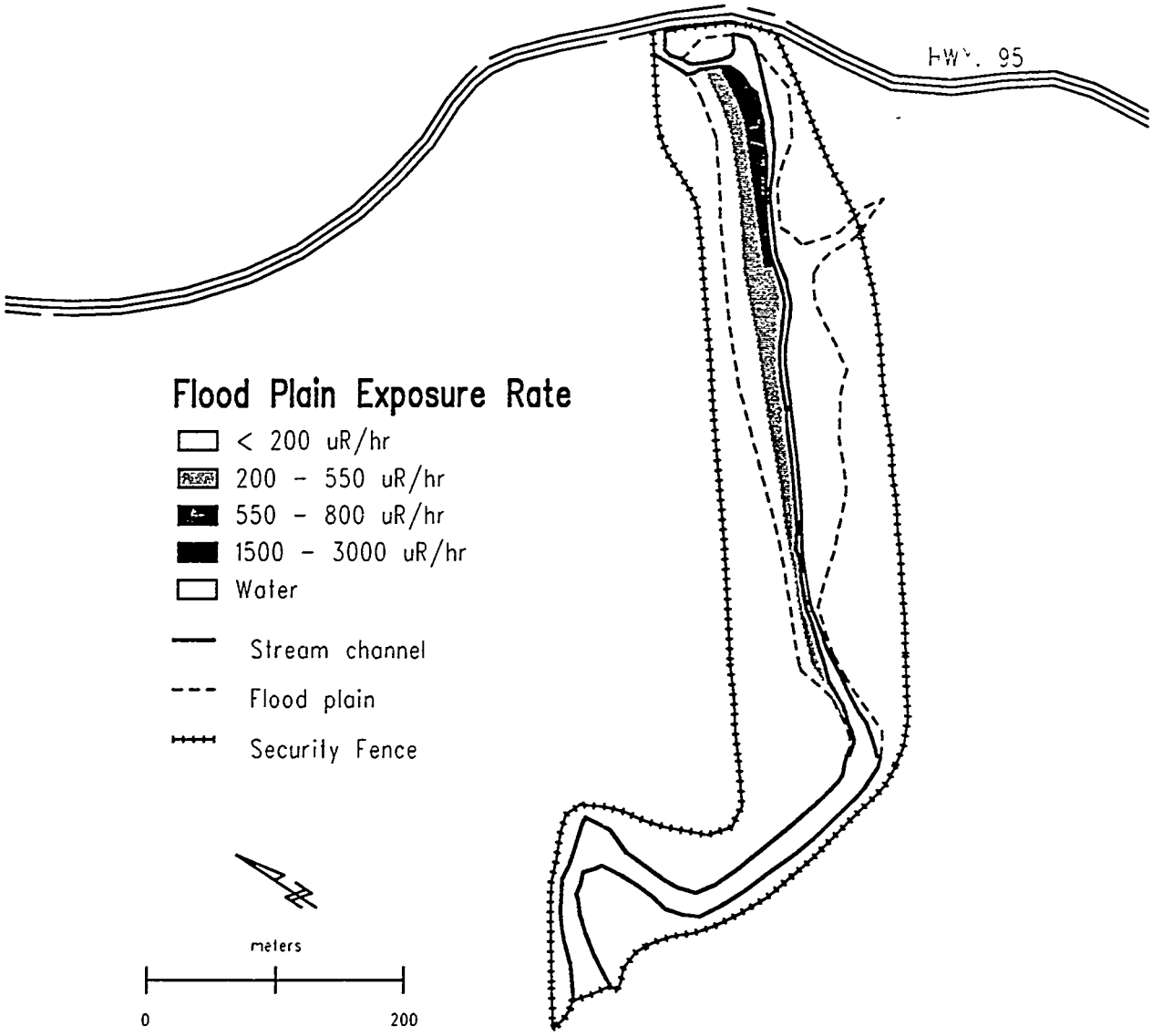


Fig. 1.12. Survey of gamma (primarily ^{137}Cs) radiation exposure rates measured 1 m above the floodplain surface when the water was at low-pool level. The shaded areas show the exposure rates on the floodplain north of the stream channel. The maximum exposure rate was 3000 μR/h.

2. SCREENING OF CONTAMINANTS IN THE WHITE OAK CREEK EMBAYMENT

2.1 INTRODUCTION

A preliminary screening of contaminants in the off-site surface water environment (Hoffman et al. 1990) indicated that WOCE was an area of concern because of the potential for external exposure to ^{137}Cs. The off-site screening analysis used historical data for WOCE. The current screening analysis of WOCE is based primarily on data collected from WOCE since the preliminary screening by Hoffman et al. (1990) was completed.

It is emphasized that the exposure pathways used in this screening analysis are entirely hypothetical. The embayment is surrounded by a security fence, and only authorized personnel are permitted entry; nevertheless, for the purpose of this contaminant screening analysis, it was assumed that the public has limited access to the area. A screening analysis based on ecological effects was not included in the present study because the embayment is a relatively small area and any ecological effects within its boundary are unlikely to have a significant impact on biota in the surrounding area.

In 1992, Clinch River RI data collected from WOCE were independently validated against EPA quality assurance criteria. This review showed that results for certain analytes in some samples were unacceptable and should not be used. Appendix summary tables for Clinch River RI data list only the validated results and qualifiers except for two notable instances. In the first case, tritium and ^{90}Sr results for water were rejected because of improper sample preservation; however, the results are within the range of ORNL radiological monitoring data collected over the same time period and are included in the summary table and in the contaminant screening analysis. In the second case, sediment grab samples analyzed for gamma-emitting radionuclides by the ORNL Health and Safety Research Division Measurement Application Development Laboratory were not validated because laboratory quality control data were not available. These nonvalidated results were compared to historical data and/or results for co-located Clinch River RI samples that were validated. The results compared favorably and were considered reliable estimates of surface sediment concentrations. All nonvalidated results have a qualifier of "NOTV."

The validated results were within the ranges of the previous data; therefore, the human health screening analysis was not revised. Conclusions would not have changed by revising the screening analysis with the validated data.

2.2 APPROACH

Both conservative and nonconservative contaminant screening procedures, similar to those used by Hoffman et al. (1990), were used in this screening analysis. The conservative approach is highly unlikely to underestimate potential maximum exposures to individuals using the embayment but may substantially overestimate the majority of the actual exposures to individuals. The nonconservative approach provides a more realistic estimate of exposure and should not substantially overestimate the maximum exposure to individuals. Under some circumstances, nonconservative screening could underestimate maximum exposures. In

addition, calculations were made for a hypothetical intruder scenario—not for screening purposes but to determine a realistic level of risk to a fisherman who illegally enters and fishes in the embayment.

2.3 SCREENING INDEXES

The screening index for a carcinogen is an estimate of exposure to the contaminant via external exposure, ingestion, or inhalation multiplied by an EPA-approved or -suggested slope factor for radioactive and nonradioactive substances to indicate the potential lifetime risk of excess cancer (EPA 1990). The slope factor provides an estimate of the lifetime risk of additional cancer incidence per unit exposure.

The screening index for noncarcinogens is an estimate of the daily ingestion or inhalation of the contaminant divided by a "reference dose factor." The reference dose is an EPA-approved noncarcinogenic contaminant exposure level below which adverse effects should not occur.

To estimate the potential risk from all contaminants in a particular exposure pathway, the screening indexes are totalled among all contaminants in a pathway. Summation is conducted separately for carcinogens and noncarcinogens. To estimate the potential risk from exposure to multiple pathways, the screening indexes are totalled across pathways.

2.4 PATHWAYS

Because WOCE is surrounded by a personnel exclusion fence and the size of the area is relatively small, the number of exposure pathways considered in the present screening assessment is limited. Four pathways were considered for both conservative and nonconservative screening: (1) external exposure to shoreline sediments, (2) ingestion of sediments, (3) ingestion of fish, and (4) ingestion of water. The inhalation pathway was not considered in this analysis because it was of relatively minor consequence in the previous screening exercise (Hoffman et al. 1990).

2.5 DATA

The data represent measurements of contaminants in sediment, water, and fish. Appendixes A through G contain itemized data and data summaries from which the screening data were derived. All data are from samples collected in 1989 and 1990 except for the organic and inorganic contaminants in sediments. Because only one core sample collected in 1990 had been analyzed for organic and inorganic contaminants (Table 1 of Appendix C), data from TVA sediment cores (TVA 1986) (Appendix B) were included in the data base. Since that time, two additional sediment cores from the embayment were analyzed for organic contaminants (cores 55300O and 55500O) and three for inorganic contaminants (cores 54100T, 54300T, and 63500T) (Fig. 1.6). A comparison of the data from these cores (Table 2 of Appendix C) with the earlier data (Table 1 of Appendix C) is provided in Sects. 1.3.4 and 1.3.5 of this report.

Thirty-one additional core samples (Fig. 1.6) were collected and analyzed for gamma-emitting radionuclides after core 9500G was collected in 1990. Because of the large quantity of additional data contributed by these cores and the fact that concentrations of radionuclides found in the latest cores differ from those reported previously (Sect. 1.3.3), the human health screening analysis for radionuclides in sediment has been updated to include the new data.

The available data were divided into two data sets (Table 2.1) consisting of (1) contaminants for which at least one measurement for a contaminant was above the level of detection (detectable contaminants) and (2) contaminants for which all measurements were below the level of detection (nondetectable contaminants). Although values for contaminants detected at concentrations less than the contract-required quantitation were reported as estimates, these contaminants were included with the detectable contaminants. For conservative screening, the upper 95% confidence limit of the arithmetic mean (EPA 1989) for each contaminant in both the detectable and nondetectable contaminants data sets was used to represent the contaminant concentration. For nonconservative screening, the geometric mean of each contaminant in the detectable contaminants data set was used as the contaminant concentration. For the nondetectable contaminants data set, the upper 95% confidence limit of the arithmetic mean of the detection limits and the lowest detection limit that was available in the data base were used as the contaminant concentration for conservative and nonconservative screening, respectively (Table 2.1).

Table 2.1. Values used for contaminant concentrations in conservative and nonconservative screening and intruder scenarios

	Screening scenarios	
Data base	Conservative	Nonconservative and intruder[a]
Detectable contaminants	Upper 95% confidence limit of the arithmetic mean	Geometric mean
Nondetectable contaminants	Upper 95% confidence limit of the arithmetic mean	Lowest limit of detection for the contaminant reported in the data base

[a]The intruder scenario was not applied to the nondetectable contaminants data base.

2.6 USAGE FACTORS

The usage factors for conservative screening listed in Table 2.2 are from Hoffman et al. (1990). For nonconservative screening, usage factors were taken as one-tenth the value used for conservative screening (Table 2.2). Hoffman et al. (1990) used a 70-year lifetime exposure for radionuclides. Recently, EPA reconsidered the maximum lifetime exposure duration for an individual and now recommends using a lifetime exposure period of 350 d/year for 30 years (OSWER 1991). A 30-year lifetime exposure was used in the present radiological screening analysis.

Table 2.2. Usage factors for conservative and nonconservative screening

Exposure route	Conservative screening	Nonconservative screening
Ingestion		
Fish	20 g/d	2 g/d
Drinking water	2 L/d	0.2 L/d
Sediment ingestion	0.1 g/d	0.01 g/d
External exposure		
Radioactive sediments	1000 h/year	100 h/year

2.7 INTRUDER SCENARIO

In addition to the conservative and nonconservative screening scenarios, calculations were made for an intruder scenario. This hypothetical scenario represents a more realistic situation that could occur under current conditions and provides a reasonable estimate of risk to a maximally exposed individual. The scenario selected was for a fisherman who illegally enters the embayment at the mouth of White Oak Creek and remains in the embayment for 4 h per incursion. The intruder enters the embayment 12 times each year for 10 years and each time catches enough fish for one meal of 500 g. In this scenario, only two exposure pathways, external radiation from sediment and ingestion of fish, were considered.

2.8 SCREENING CRITERIA

According to EPA (*Federal Register* 1990c), a risk of $\geq 10^{-4}$ excess cancers for a lifetime exposure to carcinogens is considered an action level that requires immediate consideration for remedial action. Between 10^{-4} and 10^{-6} risk is an area of concern where negotiation on remedial action alternatives occurs and additional investigation is often required. Carcinogens having a risk below 10^{-6} are of less concern and can be assigned a lower priority for further investigation. The purpose of conservative screening is to identify contaminants that have a low priority for further investigation. In contrast, nonconservative screening is used to identify contaminants with high priority for either immediate consideration for remedial action or further study.

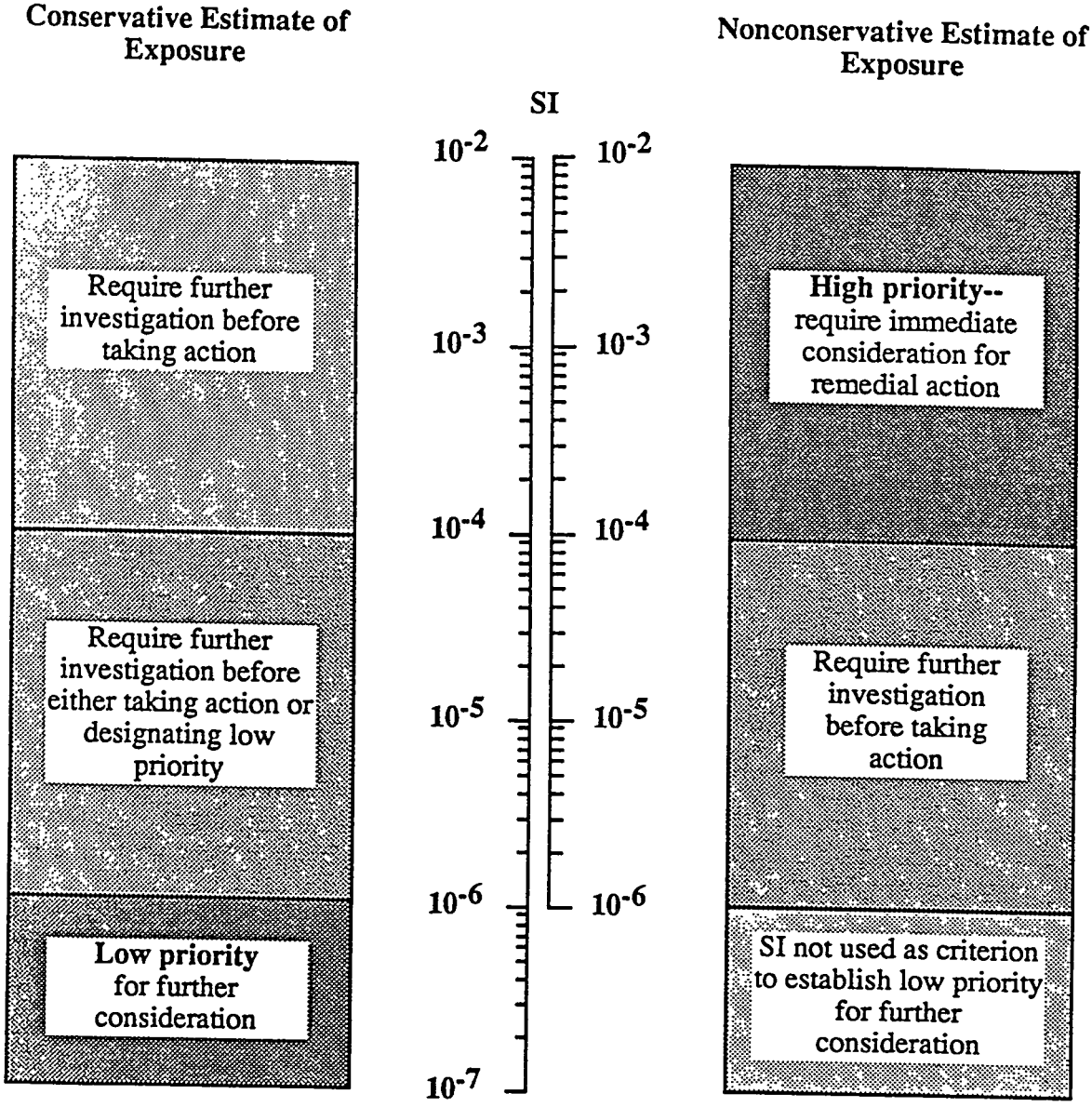
Screening criteria used in this report are summarized in Figs. 2.1 and 2.2. For conservative screening, carcinogens having screening indexes of $\leq 10^{-6}$ are of low priority for further consideration (Fig. 2.1). Carcinogens having screening indexes between $10^{-6}$and 10^{-4} are of potentially low priority and require further investigation before either taking action or designating these contaminants as low priority. Carcinogens having screening indexes of $\geq 10^{-4}$ require further investigation before taking action.

For nonconservative screening, carcinogens having screening indexes of $\geq 10^{-4}$are high priority contaminants requiring immediate consideration for remedial action (Fig. 2.1). Carcinogens with screening indexes between 10^{-4} and 10^{-6} are substances requiring further investigation before taking action (i.e., examination of the data base, checking parameter values, recalculating screening indexes, additional sampling, etc.). Because nonconservative

screening employs parameter values that should not greatly overestimate maximum exposures to a contaminant, nonconservative screening is not used to identify contaminants with low priority for further consideration.

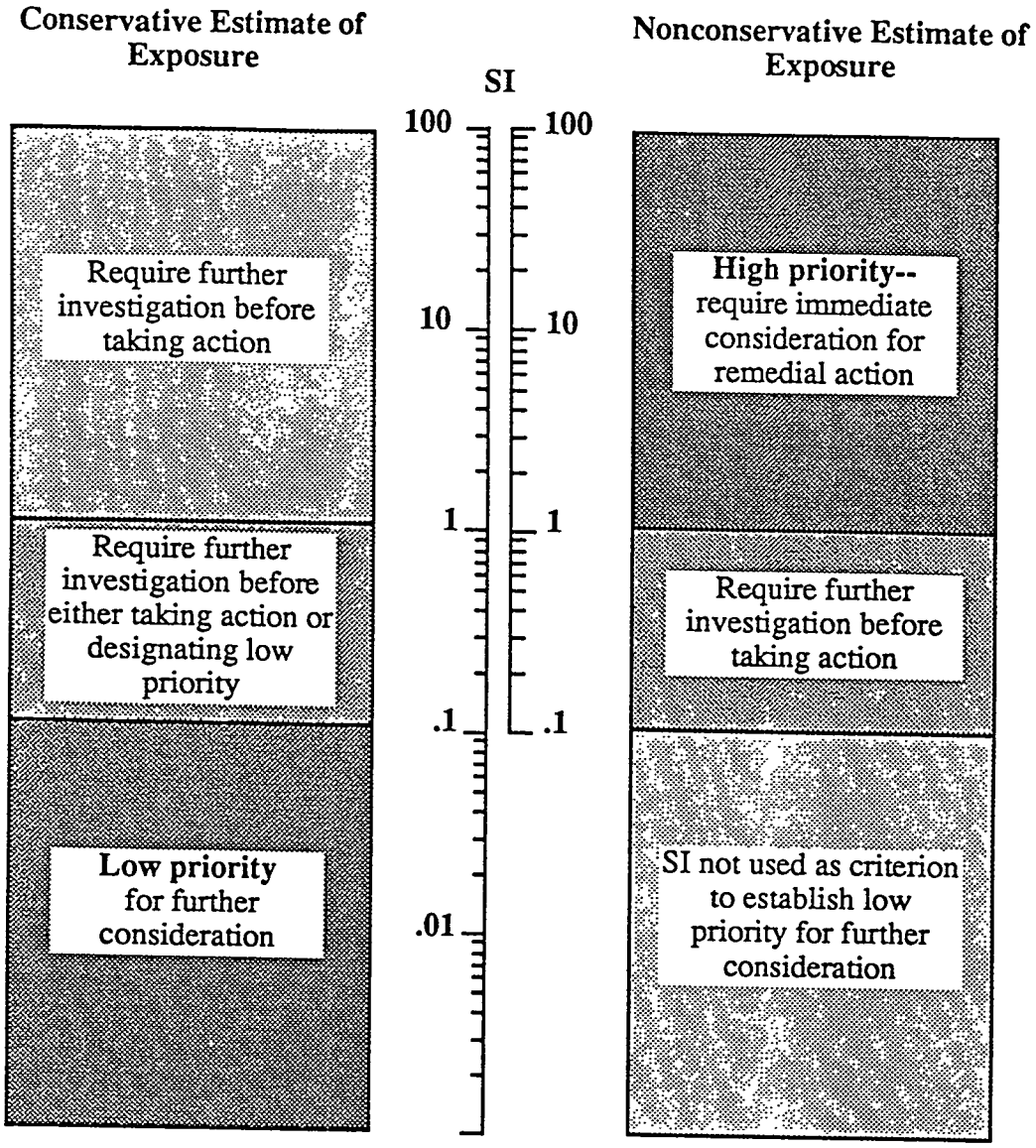
Figure 2.2 summarizes the screening criteria for noncarcinogens. For conservative screening of noncarcinogens, contaminants with screening indexes (exposure divided by a reference dose) of ≤ 0.1 are of low priority for further consideration, and contaminants with screening indexes between 1.0 and 0.1 require further investigation before either taking action or designating them as low priority substances. Noncarcinogens with conservative screening indexes of ≥ 1.0 require further investigation before taking action.

For nonconservative screening of noncarcinogens, contaminants with screening indexes of ≥ 1.0 are high priority contaminants requiring immediate consideration for remedial action, and contaminants with screening indexes between 1.0 and 0.1 require further investigation before action is taken (Fig. 2.2). Screening indexes of <0.1 are not used to designate low priority for reasons similar to those previously stated for nonconservative screening of carcinogens.



Screening index (SI) = exposure multiplied by a lifetime cancer slope factor.

Fig. 2.1 Criteria for conservative and nonconservative screening of carcinogens.



Screening index (SI) = exposure divided by reference dose factor (RfD).

Fig. 2.2 Criteria for conservative and nonconservative screening of noncarcinogens.

3. CONTAMINANT SCREENING RESULTS

3.1 DETECTABLE CONTAMINANTS

Results of conservative and nonconservative screening for each contaminant which had at least one value above detection limits are given in Appendix H and Appendix I, respectively. Results of the screening for the intruder scenario are given in Appendix J.

3.1.1 Conservative Screening

3.1.1.1 Carcinogens

The purpose of conservative screening is to identify contaminants that can be assigned a low priority for further investigation. A summary of the screening indexes for conservative screening of carcinogens in the detectable contaminants data base is given in Table 3.1. The detectable contaminants data base includes only those contaminants with at least one value for a particular medium that was above the limits of detection. The screening indexes are summed by pathway (ingestion of fish, water, and sediment and external exposure to radiation) for each class of contaminant (organics, inorganics, and radionuclides). In Table 3.1, the screening indexes for all classes of contaminants and all exposure pathways are $\geq 10^{-6}$; therefore, no class of contaminant or exposure pathway can be designated as low priority for further consideration.

Complete results of the conservative screening of carcinogens with values above detection limits are given in Table 1 of Appendix H. Individual contaminants are listed according to screening category in Table 3.2. One inorganic contaminant, one organic contaminant, and eight radionuclides in the sediment ingestion pathway were identified as low priority for further consideration. In addition, five radionuclides in the external exposure pathway and one in the water ingestion pathway also had screening indexes of $<10^{-6}$ and would be assigned to the same category. The remaining carcinogens in this data base had screening indexes of $>10^{-6}$ which placed them in a category requiring further investigation.

3.1.1.2 Noncarcinogens

A summary of the conservative screening indexes for classes of contaminants and exposure pathways for the noncarcinogens where at least one measurement was above detection limits is given in Table 3.3. All organics in the sediment and water ingestion pathways (screening indexes of <0.1) were identified as low priority for further consideration. Table 3.4 lists the individual contaminants that were assigned a low priority for further consideration. They are selenium, arsenic, and zinc in the fish ingestion pathway; arsenic, zinc, chromium, silver, cadmium, nickel, uranium, and beryllium in the sediment ingestion pathway; and zinc, cadmium, nickel, and mercury in the water ingestion pathway. Mercury in the fish and sediment ingestion pathways, chromium in the water ingestion pathway, and chlordane in the fish ingestion pathway have screening indexes between 0.1 and 1.0 and require further investigation before either taking action or designating these contaminants as low priority. Arsenic in the water ingestion pathway was the only contaminant that had a screening index of >1.0, which would require further investigation before taking action. The complete results of the conservative screening of the noncarcinogens in the data base of detected contaminants are given in Table 2 of Appendix H.

Table 3.1. Summary table for conservative screening of detected carcinogens

Media	Contaminant type	Sums of carcinogen screening indexes
Fish	Inorganic	7E–05[a]
Fish	Organic	5E–03
Fish	Radionuclide	9E–05
Fish	Total	5E–03
External exposure	Radionuclide	2E–01
External exposure	External total	2E–01
Sediment	Inorganic	4E–05
Sediment	Organic	5E–05
Sediment	Radionuclide	3E–04
Sediment	Ingestion total	4E–04
Water	Inorganic	3E–03
Water	Organic	4E–04
Water	Radionuclide	1E–03
Water	Total	4E–03
All	**Grand total**	**2E–01**

[a]7E–05 = 7×10^{-5}

Table 3.2 Carcinogens assigned to different screening categories by conservative screening of data base where at least one value or each contaminant was above detection limits

Contaminant type	Contaminant	Exposure pathway
	Low priority for further consideration	
	Screening indexes $<10^{-6}$	
Inorganic	Uranium	Sediment ingestion
Organic	Bis(2-ethylhexyl)phthalate	Sediment ingestion
Radionuclide	^{238}Pu	Water ingestion
	^{239}Pu	Sediment ingestion
	^{239}Pu	Sediment ingestion
	^{234}U	Sediment ingestion
	^{238}U	Sediment ingestion
	^{60}Co	Sediment ingestion
	^{235}U	Sediment ingestion
	^{152}Eu	Sediment ingestion
	^{154}Eu	Sediment ingestion
	^{239}Pu	External exposure
	^{235}U	External exposure
	^{238}Pu	External exposure
	^{234}U	External exposure
	^{238}U	External exposure
	Require further investigation before taking action	
	or designating as low priority	
	Screening indexes 10^{-6} to 10^{-4}	
Inorganic	Arsenic	Fish ingestion
	Arsenic	Sediment ingestion
	Beryllium	Sediment ingestion
Organic	Chlordane	Fish ingestion
	4,4'-DDD	Fish ingestion
	Aroclor-1254	Sediment ingestion
	Aroclor-1260	Sediment ingestion
	Trichloroethylene	Water ingestion
	Chloroform	Water ingestion
Radionuclide	^{137}Cs	Fish ingestion
	^{90}Sr	Fish ingestion
	^{60}Co	Water ingestion
	^{244}Cm	Water ingestion
	^{241}Am	Water ingestion
	^{238}Pu	Water ingestion
	^{90}Sr	Sediment ingestion
	^{241}Am	External exposure

Table 3.2 (continued)

Contaminant type	Contaminant	Exposure pathway
	Require further investigation before taking action *Screening indexes* $\geq 10^{-4}$	
Inorganic	Arsenic	Water ingestion[a]
Organic	Aroclor-1254	Fish ingestion
	Aroclor-1260	Fish ingestion
	PCBs total	Water ingestion
Radionuclide	^{137}Cs	External exposure
	^{137}Cs	Sediment ingestion
	^{137}Cs	Water ingestion
	^{60}Co	External exposure
	^{3}H	Water ingestion
	^{90}Sr	Water ingestion
	^{152}Eu	External exposure
	^{152}Eu	External exposure

[a]Potential artifact

Table 3.3. Summary table for conservative screening of detected noncarcinogens

Media	Contaminant type	Sums of noncarcinogen screening indexes
Fish	Inorganic	3E–01
Fish	Organic	3E–01
Fish	Total	6E–01
Sediment	Inorganic	6E–01
Sediment	Organic	8E–05
Sediment	Total	6E–01
Water	Inorganic	2E+00
Water	Organic	2E–02
Water	Total	2E+00
All	**Grand total**	**3E+00**

Table 3.4. Noncarcinogens assigned to different screening categories by conservative screening of data base where at least one value for each contaminant was above detection limits

Contaminant type	Contaminant	Exposure pathway
	Low priority for further consideration Screening indexes <0.1	
Inorganic	Selenium	Fish ingestion
	Arsenic	Fish ingestion
	Arsenic	Sediment ingestion
	Zinc	Fish ingestion
	Zinc	Water ingestion
	Zinc	Sediment ingestion
	Chromium	Sediment ingestion
	Silver	Sediment ingestion
	Cadmium	Sediment ingestion
	Cadmium	Water ingestion
	Nickel	Sediment ingestion
	Nickel	Water ingestion
	Uranium	Sediment ingestion
	Beryllium	Sediment ingestion
	Mercury	Water ingestion
Organic	Bis(2-ethylhexyl)phthalate	Sediment ingestion
	Diethylphthalate	Sediment ingestion
	Chloroform	Water ingestion
	Require further investigation before taking action or designating as low priority Screening indexes 0.1 to 1.0	
Inorganic	Mercury	Fish ingestion
	Mercury	Sediment ingestion
	Chromium	Water ingestion
Organic	Chlordane	Fish ingestion
	Require further investigation before taking action Screening indexes ≥1.0	
Inorganic	Arsenic	Water ingestion

3.1.2 Nonconservative Screening

3.1.2.1 Carcinogens

The purpose of nonconservative screening is to identify contaminants with a high priority for immediate consideration for remedial action. Summaries of the screening indexes for the different classes of carcinogens and exposure pathways are given in Table 3.5. These indexes were calculated using the data set where each contaminant had at least one value above the limits of detection. Classes of carcinogens identified by nonconservative screening as having screening indexes of $>10^{-4}$ are radionuclides in the external exposure pathway, organics in the fish ingestion pathway, and inorganics and radionuclides in the water ingestion pathway.

Table 3.5. Summary table for nonconservative screening of detected carcinogens

Media	Contaminant type	Sums of carcinogen screening indexes
Fish	Inorganic	4E-06
Fish	Organic	2E-04
Fish	Radionuclide	4E-06
Fish	Total	2E-04
External exposure	Radionuclide	3E-03
External exposure	External total	3E-03
Sediment	Inorganic	3E-06
Sediment	Organic	8E-07
Sediment	Radionuclide	9E-06
Sediment	Ingestion total	1E-05
Water	Inorganic	2E-04
Water	Organic	2E-05
Water	Radionuclide	1E-04
Water	Total	3E-04
All	**Grand total**	**4E-03**

Individual carcinogens designated as high priority (screening indexes of $>10^{-4}$) and those requiring further investigation (screening indexes from 10^{-4} to 10^{-6}) are listed in Table 3.6 according to contaminant type and exposure pathway. Arsenic, PCBs, ^{60}Co, and ^{137}Cs were identified as carcinogens in WOCE which are high priority and require immediate consideration for remedial action. Cesium-137 had the highest screening index (3×10^{-3}) and was the major radionuclide contributing to the external exposure pathway. Arsenic in water (Table 1 of Appendix I) may be an artifact because only 2 of the 24 samples analyzed were above the level of detection. Although the sum of the screening indexes for radionuclides in the water ingestion pathway exceeded 10^{-4} (Table 3.5), the individual radionuclides (^{3}H, ^{137}Cs, and ^{90}Sr) had screening indexes of $<10^{-4}$ (Table 1 of Appendix I) and are identified in Table 3.6 as requiring further investigation before taking action.

3.1.2.2 Noncarcinogens

A summary of the screening indexes for each class of noncarcinogen and each exposure pathway is given in Table 3.7. None of the contaminants was identified by nonconservative

Table 3.6. Carcinogens assigned to different screening categories by nonconservative screening of data base where at least one value for each contaminant was above detection limits

Contaminant type	Contaminant	Exposure pathway
	High priority—require immediate consideration for remedial action Screening indexes $\geq 10^{-4}$	
Inorganic	Arsenic	water ingestion[a]
Organic	Aroclor-1254	fish ingestion
Radionuclide	^{137}Cs	external exposure
	^{60}Co	external exposure
	Require further investigation before taking action Screening indexes 10^{-4} to 10^{-6}	
Inorganic	Arsenic	fish ingestion
	Arsenic	sediment ingestion
	Beryllium	sediment ingestion
Organic	Aroclor-1260	fish ingestion
	Chlordane	fish ingestion
	PCBs total	water ingestion
Radionuclide	^{137}Cs	fish ingestion
	^{137}Cs	sediment ingestion
	^{137}Cs	water ingestion
	^{3}H	water ingestion
	^{90}Sr	water ingestion
	^{90}Sr	sediment ingestion
	^{152}Eu	external exposure

[a]Potential artifact

screening as high priority, requiring immediate consideration for remedial action. Only inorganics in the water ingestion pathway had a screening index of >0.1, which would require further investigation. Table 3.8 shows arsenic in the water ingestion pathway as the only contaminant requiring further investigation before taking action; however, this result may be an artifact, because only 2 of 24 samples (Table 2 of Appendix I) analyzed were above the limits of detection. Complete results of the nonconservative screening of noncarcinogens are given in Table 2 of Appendix I.

3.1.3 Intruder Scenario

3.1.3.1 Carcinogens

The purpose of the intruder scenario is to represent a potential, although illegal, use of the embayment under current conditions. The assumptions of this scenario appear to be reasonable but are applicable to very few, if any, individuals because of security safeguards. However, these assumptions are generally less conservative than those used for nonconservative screening. Only two pathways, fish ingestion and external exposure, and the data with contaminant values above detection limits are considered in this scenario. A

summary of the results of the screening for carcinogens based on the intruder scenario is given in Table 3.9. Screening indexes for the fish ingestion pathway and radionuclides in the external exposure pathway were $>10^{-4}$. For the fish ingestion pathway, organics with a screening index of 2×10^{-4} were the primary carcinogens of concern. The PCBs (Aroclors) were the main contributor to the high screening index (Table 1 of Appendix J). The external

Table 3.7. Summary table for nonconservative screening of detected noncarcinogens

Media	Contaminant type	Sums of noncarcinogen screening indexes
Fish	Inorganic	2E–02
Fish	Organic	2E–02
Fish	Total	4E–02
Sediment	Inorganic	1E–02
Sediment	Organic	5E–06
Sediment	Total	1E–02
Water	Inorganic	1E–01
Water	Organic	8E–04
Water	Total	1E–01
All	**Grand total**	**2E–01**

Table 3.8. Noncarcinogens assigned to different screening categories by nonconservative screening of data base where at least one value for each contaminant was above detection limits

Contaminant type	Contaminant	Exposure pathway
High priority—require immediate consideration for remedial action *Screening indexes ≥1.0*		
None		
Require further investigation before taking action *Screening indexes 0.1 to 1.0*		
Inorganic	Arsenic	Water ingestion

Table 3.9. Summary table of intruder scenario screening indexes for detected carcinogens

Media	Contaminant type	Sums of carcinogen screening indexes
Fish	Inorganic	5E–06
Fish	Organic	2E–04
Fish	Radionuclide	5E–06
Fish	Ingestion total	2E–04
External exposure	Radionuclide	2E–04
External exposure	External total	2E–04
All		**4E–04**

exposure pathway was dominated by ^{137}Cs with a screening index of 5×10^{-4} (Table 1 of Appendix J). In the nonconservative screening analysis, external exposure to ^{137}Cs in sediment was the primary contaminant of concern with a screening index of 3×10^{-3} (Table 1 of Appendix I). Although the exposure time in the intruder scenario (48 h/year for 10 years) was less than the exposure time in the nonconservative scenario, ^{137}Cs in the intruder external exposure pathway was still the primary contaminant of concern (screening index of 5×10^{-4}). However, because fish consumption was increased in the intruder scenario, ingestion of PCBs (screening index of 1.8×10^{-4}) was of almost equal importance to the external exposure.

3.1.3.2 Noncarcinogens

A summary of the screening indexes for the noncarcinogens in the intruder scenario is shown in Table 3.10. Only the fish ingestion pathway is applicable for noncarcinogens in the intruder scenario. Both organics and inorganics in the fish ingestion pathway had screening indexes of >0.1. Mercury and chlordane were the inorganic and organic contaminants, respectively, of concern (Table 2 of Appendix J).

Table 3.10. Summary table of intruder scenario screening indexes for detected noncarcinogens

Media	Contaminant type	Sums of noncarcinogen screening indexes
Fish	Inorganic	2E–01
Fish	Organic	2E–01
Fish	Total	3E–01

3.2 NONDETECTABLE CONTAMINANTS

The nondetectable contaminants data base contains approximately three times as many contaminants as the detectable contaminants data base. Some contaminants are included in both data bases because the contaminant was present in detectable quantities in one medium and not in another. The screening would not be complete unless the nondetectable contaminant data are included in the analysis; however, caution should be exercised in interpreting the results.

3.2.1 Conservative Screening

The main purpose of conservative screening is to identify contaminants with a low priority for further consideration. Because the values for nondetectable contaminants are based on detection limits, contaminant concentrations that were used in the screening are greater than concentrations actually present in the samples. This bias can significantly increase the conservatism of the screening; therefore, the number of contaminants identified as low priority will probably be small.

3.2.1.1 Carcinogens

Conservative screening of the nondetectable contaminants data base for carcinogens showed that nine organics in the sediment ingestion pathway and one each in the fish and water ingestion pathways could be assigned a low priority for further consideration. All the remaining carcinogens had screening indexes of $\geq 10^{-6}$ in one or more exposure pathways. Complete results of the conservative screening for the nondetectable contaminants data base are given in Table 1 of Appendix K. Of the 46 organic carcinogens below the level of detection, 11 had screening indexes between 10^{-4} and 10^{-6} (Table 1 of Appendix K) for all pathways considered, thereby requiring further investigation before action is taken or the contaminants are designated as low priority. Beryllium, ^{235}U, and ^{60}Co in the fish ingestion pathway also had screening indexes between 10^{-4} and 10^{-6} and would be assigned to the same category.

3.2.1.2 Noncarcinogens

For noncarcinogens in the nondetectable contaminants data base, all metals except thallium and antimony had conservative screening indexes of ≤ 0.1 for all pathways considered and can be designated as low priority for further consideration (Table 2 of Appendix K). The high screening indexes for both thallium and antimony are based on only one water sample and therefore may be artifacts. Of the 46 organic noncarcinogens included in the screening analysis, all but 11 of these had screening indexes of <0.1 for all pathways considered and can be designated as low priority for further investigation. Two contaminants had screening indexes of >1.0 and would require further investigation before action is taken.

3.2.2 Nonconservative Screening

The results of nonconservative screening of the nondetectable contaminants are used to identify contaminants that have a high priority for either improving detection limits or determining from source-term data that releases from White Oak Lake have been in only extremely small quantities, if at all. Results of the nonconservative screening for the nondetectable contaminants data base are given in Appendix L.

3.2.2.1 Carcinogens

Seventeen organics in the nondetectable contaminants data base had nonconservative screening indexes of $\geq 10^{-4}$ (Table 1 of Appendix L) for at least one pathway, which identifies them as high priority for immediate consideration for further investigation either to improve limits of detection or to estimate concentrations from source-term data.

3.2.2.2 Noncarcinogens

Thallium in water was the only noncarcinogen with a screening index high enough (0.1) (Table 2 of Appendix L) to warrant further investigation as a result of nonconservative screening. However, this value is a potential artifact because only one water sample was analyzed.

3.3 SPECIAL CASE LEAD

Although an action level for lead of 0.015 mg/L has been adopted by EPA (EPA 1991), specific toxicity values are not available. Therefore, an EPA uptake/biokinetic model designed to a target population of children (0–6 years old) was used to evaluate the risk posed by lead in WOCE. Results obtained using this model indicate that the concentrations of lead in water and sediment would not present a problem. This result is based on a hypothetical scenario because the embayment is a fenced area where the public is not allowed.

3.4 NONCLASSIFIED CONTAMINANTS

At the time this report was prepared, no reference dose or slope factors were available for the contaminants listed below. The four inorganics identified here were present in detectable quantities in either sediment, water, and/or fish collected from WOCE. None of the organics had concentrations that were above detection limits in any samples taken. The potential toxicity and/or cancer potency of these contaminants must be evaluated before their screening indexes can be calculated.

- Organics

  1,3-Dichlorobenzene
  2-Chloronaphthalene
  2-Nitrophenol
  4-Bromophenyl-phenylether
  4-Chlorophenyl-phenylether
  4-Nitrophenol
  Bis(2-chloroethoxy)methane
  Delta-BHC
  Di-n-octylphthalate
  Endosulfan sulfate
  Endrin ketone

- Inorganics

  Aluminum
  Copper
  Lead
  Zirconium

4. CONCLUSIONS

In September 1990, the finding of relatively high concentrations of ^{137}Cs [10^6 Bq/kg dry wt (> 10^4 pCi/g dry wt)] in surface sediments at the mouth of WOCE resulted in the filing of an occurrence report and the notification of regulatory agencies. Available evidence indicates that large amounts of ^{137}Cs-contaminated sediment were released from White Oak Lake into the embayment in the mid-1950s and that they have been eroded and transported downstream. Analyses of additional sediment cores collected after July 1990 show that sediment in the depositional zone of the old stream channel is contaminated with ^{137}Cs to a depth of ~1 m. This contaminated sediment could eventually be eroded and transported into the Clinch River.

A conservative and nonconservative screening analysis was conducted on fish, water, and sediment data collected in 1990 and 1991 from White Oak Creek embayment to identify contaminants that might pose a threat to human health. The nonconservative screening of detectable carcinogens identified arsenic in water, Aroclor-1254 (a PCB) in fish, and ^{60}Co and ^{137}Cs in sediment as high-priority contaminants requiring immediate consideration. Arsenic in water is possibly an artifact because only 2 of 24 samples analyzed had concentrations above the limits of detection. Nonconservative screening did not identify any noncarcinogens as high priority contaminants requiring immediate attention. Conservative screening of carcinogens identified ten carcinogens in the sediment ingestion pathway, one in the water ingestion pathway, and five in the external exposure pathway that could be designated as low priority for further study. Ten inorganic and three organic noncarcinogens were identified by conservative screening as low priority for further consideration.

Approximately two-thirds of the contaminants had concentrations that were below the limits of detection. Results of the screening of these nondetectable contaminants must be viewed with caution because the values used in the screening analysis are based on the detection limits. Using detection limits for concentrations increases the conservatism of the screening results. For this reason, conservative screening of nondetectable contaminants identified only a few contaminants as low priority for further consideration. Nonconservative screening of the nondetectable contaminants is useful in identifying contaminants that have a high priority for improving their detection limits. Sixteen organic carcinogens were identified as high priority for either improving detection limits or using source-term data to verify the presence of these contaminants.

Other assumptions (an intruder scenario) were used to evaluate the risk to a maximally exposed individual under current conditions. An individual (assumed to be an illegal intruder with intermittent visits over a period of 10 years) using the embayment for fishing purposes would be exposed to a potential lifetime risk of $>10^{-4}$ excess cancers from external exposure to ^{137}Cs and ingestion of PCBs in fish.

Radiological data from sediment samples were used to estimate inventories of radionuclides contained in the embayment sediment. Cesium-137 is the dominant radionuclide, and the estimated inventory ranges from 6.6 to 11.8 Ci, depending on the method of calculation. The second highest inventory is for ^{90}Sr, which has an estimated 0.2 Ci in the sediment. Other radionuclides are present but occur in much lower quantities.

A walk-over radiation survey identified an area in the upper embayment with a relatively high external exposure rate ($3mRh^{-1}$), which indicates that the ^{137}Cs inventory may be underestimated. Additional samples are required to reduce the uncertainty associated with the estimated inventory in the upper embayment.

As a result of the discovery of relatively high levels of contamination in the surface sediments in the lower portion of WOCE and the subsequent site characterization efforts described in this report, DOE, acting through Energy Systems, conducted a time-critical removal action (led and funded by DOE) at WOCE pursuant to the Comprehensive ENvironmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act and provisions of the latest version of the National Contingency Plan, 40 *CFR* Part 300, March 1980. The time-critical CERCLA removal action specifically consisted of design and construction of a sediment-retention structure across the mouth of WOCE to prevent off-site migration of contaminated sediments into the CLinch River.

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Appendix A

CONCENTRATIONS OF RADIONUCLIDES IN WHITE OAK CREEK EMBAYMENT CORE SAMPLES COLLECTED IN 1977

Table A1. Summary of radionuclide concentrations in White Oak Creek Embayment core samples collected in 1977

Compound	Number	Minimum Value	Maximum Value	Mean Value	Standard Deviation	Units
CO-60	242	6.18	35899.99	2450.56	4704.06	BQ/KG
CS-137	319	6.18	3750653.00	76087.64	279432.80	BQ/KG

Table A2. Radionuclide concentrations in White Oak Creek Embayment core samples collected in 1977

Core ID[a]	Sample Depth (in)	Compound Cs-137	Compound Co-60	Units
1	1	25086.74	3089.50	BQ/KG
1	2	24716.00	2904.13	BQ/KG
1	3	16992.25	2286.23	BQ/KG
1	4	17362.99	2224.44	BQ/KG
1	5	15014.97	1112.22	BQ/KG
1	6	13840.96	865.06	BQ/KG
1	7	4819.62	370.74	BQ/KG
1	8	741.48	49.43	BQ/KG
1	13	80.33	43.25	BQ/KG
1	14	37.07	55.61	BQ/KG
1	16	12.36	12.36	BQ/KG
1	17	.	6.18	BQ/KG
2	1	30338.89	3027.71	BQ/KG
2	2	3027.71	370.74	BQ/KG
2	3	2780.55	370.74	BQ/KG
2	4	1421.17	247.16	BQ/KG
2	5	679.69	123.58	BQ/KG
2	6	185.37	49.43	BQ/KG
2	7	185.37	30.89	BQ/KG
2	13	43.25	12.36	BQ/KG
2	22	556.11	49.43	BQ/KG
3	1	19093.11	2595.18	BQ/KG
3	2	19649.22	2533.39	BQ/KG
3	3	10504.30	1421.17	BQ/KG
3	4	3954.56	494.32	BQ/KG
3	5	1421.17	185.37	BQ/KG
3	6	494.32	61.79	BQ/KG
3	7	308.95	37.07	BQ/KG
3	8	308.95	24.72	BQ/KG
3	10	49.43	12.36	BQ/KG
3	11	43.25	12.36	BQ/KG
3	12	37.07	6.18	BQ/KG
3	13	308.95	24.72	BQ/KG
3	14	123.58	30.89	BQ/KG
3	15	1359.38	185.37	BQ/KG
6	1	38618.75	4387.09	BQ/KG
6	2	31698.27	3892.77	BQ/KG
6	3	25333.90	3027.71	BQ/KG
6	4	24407.05	2904.13	BQ/KG
6	5	16065.40	1977.28	BQ/KG
6	6	1915.49	185.37	BQ/KG
6	7	803.27	123.58	BQ/KG
6	8	247.16	30.89	BQ/KG
6	9	185.37	30.89	BQ/KG
6	12	30.89	24.72	BQ/KG
6	18	1359.38	185.37	BQ/KG
7	1	97628.20	7909.12	BQ/KG
7	2	96392.40	7229.43	BQ/KG
7	3	23912.73	1977.28	BQ/KG
7	4	22800.51	1853.70	BQ/KG
7	5	21317.55	1482.96	BQ/KG
7	6	38927.70	2409.81	BQ/KG
7	7	24530.63	1421.17	BQ/KG
7	8	5993.63	370.74	BQ/KG
7	9	803.27	80.33	BQ/KG
7	10	432.53	30.89	BQ/KG
7	11	308.95	24.72	BQ/KG
7	12	432.53	24.72	BQ/KG
7	13	123.58	12.36	BQ/KG
7	14	123.58	18.54	BQ/KG
7	17	61.79	18.54	BQ/KG
7	20	741.48	61.79	BQ/KG
8	1	59874.51	3583.82	BQ/KG
8	2	19525.64	1112.22	BQ/KG
8	3	15385.71	988.64	BQ/KG
8	4	2409.81	123.58	BQ/KG
8	5	617.90	49.43	BQ/KG
8	6	308.95	18.54	BQ/KG

Table A2 (continued)

Core ID	Sample Depth (in)	Compound Cs-137	Compound Co-60	Units
8	7	123.58	24.72	BQ/KG
8	8	123.58	24.72	BQ/KG
8	9	185.37	18.54	BQ/KG
8	10	247.16	18.54	BQ/KG
8	13	61.79	12.36	BQ/KG
8	16	61.79	6.18	BQ/KG
8	20	370.74	30.89	BQ/KG
11	1	41522.88	3027.71	BQ/KG
11	2	39360.23	2965.92	BQ/KG
11	3	35776.41	2471.60	BQ/KG
11	4	26816.86	1297.59	BQ/KG
11	5	26322.54	926.85	BQ/KG
11	6	18042.68	803.27	BQ/KG
11	7	8465.23	308.95	BQ/KG
11	9	10195.35	67.97	BQ/KG
11	10	24716.00	123.58	BQ/KG
11	11	62407.90	160.65	BQ/KG
11	12	76743.18	80.33	BQ/KG
11	13	57279.33	55.61	BQ/KG
11	14	25519.27	24.72	BQ/KG
11	18	3089.50	37.07	BQ/KG
12	1	137297.38	7538.38	BQ/KG
12	2	147369.15	7847.33	BQ/KG
12	3	150149.70	7661.96	BQ/KG
12	4	167080.16	5561.10	BQ/KG
12	5	41893.62	1606.54	BQ/KG
12	6	17239.41	741.48	BQ/KG
12	7	17362.99	741.48	BQ/KG
12	8	6179.00	327.49	BQ/KG
12	9	2533.39	160.65	BQ/KG
12	10	1482.96	117.40	BQ/KG
12	11	1482.96	166.83	BQ/KG
12	12	1297.59	123.58	BQ/KG
12	13	1297.59	105.04	BQ/KG
12	14	537.57	86.51	BQ/KG
12	15	222.44	30.89	BQ/KG
12	16	61.79	12.36	BQ/KG
12	23	1977.28	67.97	BQ/KG
13	1	173938.85	9762.82	BQ/KG
13	2	132786.71	9083.13	BQ/KG
13	3	57897.23	3954.56	BQ/KG
13	4	4387.09	494.32	BQ/KG
13	5	865.06	185.37	BQ/KG
13	6	1359.38	123.58	BQ/KG
13	7	926.85	123.58	BQ/KG
13	8	432.53	49.43	BQ/KG
13	9	1977.28	185.37	BQ/KG
16	1	18104.47	1606.54	BQ/KG
16	2	7785.54	741.48	BQ/KG
16	3	4448.88	488.14	BQ/KG
16	4	2904.13	346.02	BQ/KG
16	5	1853.70	203.91	BQ/KG
16	6	1297.59	117.40	BQ/KG
16	7	803.27	43.25	BQ/KG
16	9	240.98	18.54	BQ/KG
16	10	173.01	18.54	BQ/KG
16	13	185.37	6.18	BQ/KG
17	1	305798.71	8835.97	BQ/KG
17	2	227201.83	7414.80	BQ/KG
17	3	271876.00	8527.02	BQ/KG
17	4	368762.72	9515.66	BQ/KG
17	5	440377.33	10751.46	BQ/KG
17	6	325695.09	9083.13	BQ/KG
17	7	220404.93	7909.12	BQ/KG
17	8	141931.63	6117.21	BQ/KG
17	9	88668.65	4078.14	BQ/KG
17	10	52768.66	2471.60	BQ/KG
17	11	37691.90	1730.12	BQ/KG
17	12	14149.91	617.90	BQ/KG
17	13	8032.70	537.57	BQ/KG

Table A2 (continued)

Core ID	Sample Depth (in)	Compound Cs-137	Compound Co-60	Units
17	14	5931.84	420.17	BQ/KG
17	15	1915.49	160.65	BQ/KG
17	16	617.90	67.97	BQ/KG
17	18	247.16	30.89	BQ/KG
17	22	10504.30	203.91	BQ/KG
18	1	184504.94	6426.16	BQ/KG
18	2	237088.23	7229.43	BQ/KG
18	3	251670.67	7229.43	BQ/KG
18	4	250805.61	7291.22	BQ/KG
18	5	250496.66	6858.69	BQ/KG
18	6	244070.50	6673.32	BQ/KG
18	7	211816.12	5499.31	BQ/KG
18	8	109244.72	2842.34	BQ/KG
18	9	76125.28	1977.28	BQ/KG
18	10	30091.73	803.27	BQ/KG
18	11	25210.32	741.48	BQ/KG
18	12	1544.75	49.43	BQ/KG
18	13	4634.25	117.40	BQ/KG
18	15	1359.38	37.07	BQ/KG
18	16	865.06	18.54	BQ/KG
18	21	5066.78	129.76	BQ/KG
19	1	75507.38	5313.94	BQ/KG
19	2	57402.91	3769.19	BQ/KG
19	3	18598.79	988.64	BQ/KG
19	4	8341.65	451.07	BQ/KG
19	5	7167.64	389.28	BQ/KG
19	6	1359.38	74.15	BQ/KG
19	7	1174.01	61.79	BQ/KG
19	8	253.34	18.54	BQ/KG
19	25	1050.43	61.79	BQ/KG
20	1	27125.81	2224.44	BQ/KG
20	2	16559.72	1730.12	BQ/KG
20	3	14026.33	1544.75	BQ/KG
20	4	5622.89	679.69	BQ/KG
20	5	2656.97	271.88	BQ/KG
20	6	1791.91	123.58	BQ/KG
20	7	2348.02	123.58	BQ/KG
20	8	2100.86	135.94	BQ/KG
20	9	543.75	80.33	BQ/KG
20	10	296.59	49.43	BQ/KG
20	11	451.07	61.79	BQ/KG
20	12	129.76	37.07	BQ/KG
20	13	346.02	49.43	BQ/KG
20	15	352.20	30.89	BQ/KG
20	16	339.84	30.89	BQ/KG
20	17	3089.50	240.98	BQ/KG
23	1	63025.80	2286.23	BQ/KG
23	2	60924.94	2162.65	BQ/KG
23	3	62469.69	2286.23	BQ/KG
23	4	71367.45	2656.97	BQ/KG
23	5	81686.38	3274.87	BQ/KG
23	6	86567.79	3274.87	BQ/KG
23	7	96145.24	3151.29	BQ/KG
23	8	107391.02	3089.50	BQ/KG
23	9	101768.13	2904.13	BQ/KG
23	10	102386.03	2965.92	BQ/KG
23	11	98307.89	3089.50	BQ/KG
23	12	99111.16	2656.97	BQ/KG
23	13	106031.64	2409.81	BQ/KG
23	14	113446.44	2595.18	BQ/KG
23	15	111283.79	2595.18	BQ/KG
23	16	113878.97	2595.18	BQ/KG
23	17	113508.23	2533.39	BQ/KG
23	18	126669.50	2718.76	BQ/KG
23	19	130376.90	2348.02	BQ/KG
23	20	195071.03	3645.61	BQ/KG
23	21	470221.90	7661.96	BQ/KG
23	22	797091.00	14458.86	BQ/KG
23	23	1099862.00	17424.78	BQ/KG
23	24	1309948.00	14026.33	BQ/KG

Table A2 (continued)

Core ID	Sample Depth (in)	Compound Cs-137	Compound Co-60	Units
23	25	1810447.00	23665.57	BQ/KG
23	26	3750653.00	35899.99	BQ/KG
23	27	1371738.00	30771.42	BQ/KG
23	28	982461.00	27558.34	BQ/KG
23	29	766196.00	20514.28	BQ/KG
23	30	363016.25	8897.76	BQ/KG
23	30.5	98246.10	3954.56	BQ/KG
23	31	56661.43	2471.60	BQ/KG
23	32	95589.13	3707.40	BQ/KG
23	33	36456.10	2904.13	BQ/KG
23	34	33490.18	2965.92	BQ/KG
23	35	180859.33	4696.04	BQ/KG
24	1	32501.54	741.48	BQ/KG
24	2	29226.67	679.69	BQ/KG
24	3	33366.60	803.27	BQ/KG
24	4	36085.36	865.06	BQ/KG
24	5	29041.30	617.90	BQ/KG
24	6	27125.81	679.69	BQ/KG
24	7	15941.82	444.89	BQ/KG
24	8	10133.56	302.77	BQ/KG
24	9	59689.14	988.64	BQ/KG
24	10	146380.51	2100.86	BQ/KG
24	11	252659.31	2100.86	BQ/KG
24	12	267612.49	1668.33	BQ/KG
24	13	192166.90	1359.38	BQ/KG
24	14	265944.16	1977.28	BQ/KG
24	15	219416.29	1174.01	BQ/KG
24	16	66177.09	407.81	BQ/KG
24	17	21193.97	173.01	BQ/KG
24	18	18351.63	179.19	BQ/KG
24	19	18475.21	210.09	BQ/KG
24	20	36641.47	494.32	BQ/KG
24	21	116968.47	1853.70	BQ/KG
24	22	88174.33	18.54	BQ/KG

[a]Cores 13, 18, 19, 23, and 24 were used to calculate radionuclide inventories.

Appendix B

CONCENTRATIONS OF CONTAMINANTS IN TVA CORE SAMPLES COLLECTED IN WHITE OAK CREEK IN 1984

Table B1. Summary of contaminant concentrations in TVA core samples collected in 1984

Analysis Type	Compound	Number	Minimum Qualifier	Minimum Value	Maximum Qualifier	Maximum Value	Mean Value	Standard Deviation	Units
METALS									
	ARSENIC	4		5.00		12.00	8.25	3.77	MG/KG
	CADMIUM	4		0.60		2.60	1.62	0.93	MG/KG
	CHROMIUM	4		66.00		290.00	183.00	118.48	MG/KG
	CYANIDE	4	U	1.00	U	1.00	1.00	0.00	MG/KG
	LEAD	4		33.00		51.00	40.25	7.63	MG/KG
	MERCURY	4	A	2.20	A	6.00	3.40	1.75	MG/KG
	NICKEL	4		25.00		30.00	26.25	2.50	MG/KG
	SILVER	4		2.00		10.00	6.25	3.86	MG/KG
	URANIUM	23		0.30		18.00	4.71	3.87	MG/KG
	ZIRCONIUM	4		260.00		450.00	352.50	96.39	MG/KG
ORGANICS									
	ACENAPHTHENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	ACENAPHTHYLENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	ANTHRACENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	BENZIDINE	4	U	3.20	U	4.10	3.80	0.42	MG/KG
	BENZO(A)ANTHRACENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	BENZO(B)FLUORANTHENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	BENZO(GHI)PERYLENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	BENZO(K)FLUORANTHENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	BENZO-A-PYRENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	BIS (2-CHLOROETHOXY) METHANE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	BIS (2-CHLOROETHYL) ETHER	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	BIS (2-CHLOROISOPROPYL) ETHER	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	BIS (2-ETHYLHEXYL) PHTHALATE	4	U	0.63		1.60	0.95	0.44	MG/KG
	CHRYSENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	DI-N-BUTYL PHTHALATE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	DI-N-OCTYL PHTHALATE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	DIETHYL PHTHALATE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	DIMETHYL PHTHALATE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	FLUORANTHENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	FLUORENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	HEXACHLOROBENZENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	HEXACHLOROBUTADIENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	HEXACHLOROCYCLOPENTADIENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	HEXACHLOROETHANE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	INDENO (1,2,3-CD) PYRENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	ISOPHORONE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	N-BUTYL BENZYL PHTHALATE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	N-NITROSODI-N-PROPYLAMINE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	N-NITROSODIMETHYLAMINE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	N-NITROSODIPHENYLAMINE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	NAPHTHALENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	NITROBENZENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	PCB-1016	4	U	0.10	U	0.10	0.10	0.00	MG/KG
	PCB-1221	4	U	0.10	U	0.10	0.10	0.00	MG/KG
	PCB-1232	4	U	0.10	U	0.10	0.10	0.00	MG/KG
	PCB-1242	4	U	0.10	U	0.10	0.10	0.00	MG/KG
	PCB-1248	4	U	0.10	U	0.10	0.10	0.00	MG/KG
	PCB-1254	4	U	0.10		1.20	0.37	0.55	MG/KG
	PCB-1260	4	U	0.10		1.60	0.47	0.75	MG/KG
	PHENANTHRENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	PHENOLS	4	U	0.40	U	0.40	0.40	0.00	MG/KG
	PYRENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	1,2-DICHLOROBENZENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	1,2-DIPHENYLHYDRAZINE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	1,2,4-TRICHLOROBENZENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	1,2,5,6-DIBENZANTHRACENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	1,3-DICHLOROBENZENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	1,4-DICHLOROBENZENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	2-CHLORONAPHTHALENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	2,4-DINITROTOLUENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	2,6-DINITROTOLUENE	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	3,3'-DICHLOROBENZIDINE	4	U	1.60	U	2.10	1.92	0.24	MG/KG
	4-BROMOPHENYL PHENYL ETHER	4	U	0.63	U	0.82	0.75	0.09	MG/KG
	4-CHLOROPHENYL PHENYL ETHER	4	U	0.63	U	0.82	0.75	0.09	MG/KG

Table B1 (continued)

Analysis Type	Compound	Number	Minimum Qualifier	Minimum Value	Maximum Qualifier	Maximum Value	Mean Value	Standard Deviation	Units
RADIONUCLIDES									
	AC-228	20		37.00		259.00	94.90	55.32	BQ/KG
	AM-241	15		15.91		2701.00	402.02	671.23	BQ/KG
	BI-212	2		111.00		111.00	111.00	0.00	BQ/KG
	BI-214	15		22.20		62.90	45.39	10.42	BQ/KG
	CO-60	23		444.00		16169.00	4275.91	3545.68	BQ/KG
	CS-134	18		7.40		62.90	24.46	15.34	BQ/KG
	CS-137	23		6956.00		1737076.00	291650.09	417175.81	BQ/KG
	CM-244	9		0.52		444.00	121.02	155.80	BQ/KG
	EU-152	7		48.10		329.30	216.71	106.25	BQ/KG
	EU-154	19		19.98		518.00	197.54	162.29	BQ/KG
	PB-212	20		37.00		185.00	81.03	44.99	BQ/KG
	PB-214	5		37.00		51.80	44.40	6.92	BQ/KG
	PU-238	9		0.26		151.70	23.07	48.63	BQ/KG
	PU-239	9		13.32		2553.00	335.10	832.16	BQ/KG
	SR-89	23	M	11.10	M	6327.00	1256.87	1640.39	BQ/KG
	SR-90	23		74.00		29600.00	5809.00	7931.53	BQ/KG
	TH-234	1		74.00		74.00	74.00	.	BQ/KG
	TL-208	7		14.80		51.80	26.27	12.29	BQ/KG

U = below the limit of detection.
A = duplicate samples averaged.
M = presence of material verified but not quantified.

Table B2. Contaminant concentrations in TVA core samples collected in 1984

Sample Site(mi)	Type of Analysis	Compound	Upper Depth(in)	Lower Depth(in)	Qualifier	Value	Units
WOC 0.18	METAL	ARSENIC	.	.		11.00	MG/KG
		CADMIUM	.	.		0.60	MG/KG
		CHROMIUM	.	.		66.00	MG/KG
		CYANIDE	.	.	U	1.00	MG/KG
		LEAD	.	.		51.00	MG/KG
		MERCURY	.	.	A	6.00	MG/KG
		NICKEL	.	.		30.00	MG/KG
		SILVER	.	.		4.00	MG/KG
		URANIUM	.	.		3.90	MG/KG
		URANIUM	0.1	3.9		1.50	MG/KG
		URANIUM	4.0	7.9		2.30	MG/KG
		URANIUM	8.0	11.8		18.00	MG/KG
		URANIUM	11.9	15.7		4.80	MG/KG
		ZIRCONIUM	.	.		260.00	MG/KG
WOC 0.18	ORGANIC	ACENAPHTHENE	.	.	U	0.75	MG/KG
		ACENAPHTHYLENE	.	.	U	0.75	MG/KG
		ANTHRACENE	.	.	U	0.75	MG/KG
		BENZIDINE	.	.	U	3.80	MG/KG
		BENZO(A)ANTHRACENE	.	.	U	0.75	MG/KG
		BENZO(B)FLUORANTHENE	.	.	U	0.75	MG/KG
		BENZO(GHI)PERYLENE	.	.	U	0.75	MG/KG
		BENZO(K)FLUORANTHENE	.	.	U	0.75	MG/KG
		BENZO-A-PYRENE	.	.	U	0.75	MG/KG
		BIS (2-CHLOROETHOXY) METHANE	.	.	U	0.75	MG/KG
		BIS (2-CHLOROETHYL) ETHER	.	.	U	0.75	MG/KG
		BIS (2-CHLOROISOPROPYL) ETHER	.	.	U	0.75	MG/KG
		BIS (2-ETHYLHEXYL) PHTHALATE	.	.	U	0.75	MG/KG
		CHRYSENE	.	.	U	0.75	MG/KG
		DI-N-BUTYL PHTHALATE	.	.	U	0.75	MG/KG
		DI-N-OCTYL PHTHALATE	.	.	U	0.75	MG/KG
		DIETHYL PHTHALATE	.	.	U	0.75	MG/KG
		DIMETHYL PHTHALATE	.	.	U	0.75	MG/KG
		FLUORANTHENE	.	.	U	0.75	MG/KG
		FLUORENE	.	.	U	0.75	MG/KG
		HEXACHLOROBENZENE	.	.	U	0.75	MG/KG
		HEXACHLOROBUTADIENE	.	.	U	0.75	MG/KG
		HEXACHLOROCYCLOPENTADIENE	.	.	U	0.75	MG/KG
		HEXACHLOROETHANE	.	.	U	0.75	MG/KG
		INDENO (1,2,3-CD) PYRENE	.	.	U	0.75	MG/KG
		ISOPHORONE	.	.	U	0.75	MG/KG
		N-BUTYL BENZYL PHTHALATE	.	.	U	0.75	MG/KG
		N-NITROSODI-N-PROPYLAMINE	.	.	U	0.75	MG/KG
		N-NITROSODIMETHYLAMINE	.	.	U	0.75	MG/KG
		N-NITROSODIPHENYLAMINE	.	.	U	0.75	MG/KG
		NAPHTHALENE	.	.	U	0.75	MG/KG
		NITROBENZENE	.	.	U	0.75	MG/KG
		PCB-1016	.	.	U	0.10	MG/KG
		PCB-1221	.	.	U	0.10	MG/KG
		PCB-1232	.	.	U	0.10	MG/KG
		PCB-1242	.	.	U	0.10	MG/KG
		PCB-1248	.	.	U	0.10	MG/KG
		PCB-1254	.	.		1.20	MG/KG
		PCB-1260	.	.		1.60	MG/KG
		PHENANTHRENE	.	.	U	0.75	MG/KG
		PHENOLS	.	.	U	0.40	MG/KG
		PYRENE	.	.	U	0.75	MG/KG
		1,2-DICHLOROBENZENE	.	.	U	0.75	MG/KG
		1,2-DIPHENYLHYDRAZINE	.	.	U	0.75	MG/KG
		1,2,4-TRICHLOROBENZENE	.	.	U	0.75	MG/KG
		1,2,5,6-DIBENZANTHRACENE	.	.	U	0.75	MG/KG
		1,3-DICHLOROBENZENE	.	.	U	0.75	MG/KG
		1,4-DICHLOROBENZENE	.	.	U	0.75	MG/KG
		2-CHLORONAPHTHALENE	.	.	U	0.75	MG/KG
		2,4-DINITROTOLUENE	.	.	U	0.75	MG/KG
		2,6-DINITROTOLUENE	.	.	U	0.75	MG/KG
		3,3'-DICHLOROBENZIDINE	.	.	U	1.90	MG/KG
		4-BROMOPHENYL PHENYL ETHER	.	.	U	0.75	MG/KG
		4-CHLOROPHENYL PHENYL ETHER	.	.	U	0.75	MG/KG

Table B2 (continued)

Sample Site(mi)	Type of Analysis	Compound	Upper Depth(in)	Lower Depth(in)	Qualifier	Value	Units
WOC 0.18	RADIO-NUCLIDES	AC-228	.	.		148.00	BQ/KG
		AC-228	0.1	3.9		37.00	BQ/KG
		AC-228	4.0	7.9		92.50	BQ/KG
		AC-228	11.9	15.7		81.40	BQ/KG
		AM-241	0.1	3.9		81.40	BQ/KG
		AM-241	4.0	7.9		133.20	BQ/KG
		AM-241	8.0	11.8		518.00	BQ/KG
		AM-241	11.9	15.7		17.76	BQ/KG
		BI-214	0.1	3.9		44.40	BQ/KG
		BI-214	4.0	7.9		51.80	BQ/KG
		BI-214	11.9	15.7		44.40	BQ/KG
		CO-60	.	.		4033.00	BQ/KG
		CO-60	0.1	3.9		1998.00	BQ/KG
		CO-60	4.0	7.9		4625.00	BQ/KG
		CO-60	8.0	11.8		16169.00	BQ/KG
		CO-60	11.9	15.7		1332.00	BQ/KG
		CS-134	0.1	3.9		11.10	BQ/KG
		CS-134	0.1	3.9		22.20	BQ/KG
		CS-134	4.0	7.9		18.50	BQ/KG
		CS-134	4.0	7.9		62.90	BQ/KG
		CS-137	.	.		448366.00	BQ/KG
		CS-137	0.1	3.9		70337.00	BQ/KG
		CS-137	4.0	7.9		78218.00	BQ/KG
		CS-137	8.0	11.8		1737076.00	BQ/KG
		CS-137	11.9	15.7		23532.00	BQ/KG
		CM-244	0.1	3.9		23.31	BQ/KG
		CM-244	4.0	7.9		255.30	BQ/KG
		CM-244	8.0	11.8		14.80	BQ/KG
		CM-244	11.9	15.7		0.52	BQ/KG
		EU-152	4.0	7.9		259.00	BQ/KG
		EU-154	.	.		111.00	BQ/KG
		EU-154	0.1	3.9		59.20	BQ/KG
		EU-154	4.0	7.9		296.00	BQ/KG
		EU-154	8.0	11.8		518.00	BQ/KG
		PB-212	.	.		148.00	BQ/KG
		PB-212	0.1	3.9		66.60	BQ/KG
		PB-212	4.0	7.9		111.00	BQ/KG
		PB-212	11.9	15.7		66.60	BQ/KG
		PB-214	11.9	15.7		51.80	BQ/KG
		PU-238	0.1	3.9		3.33	BQ/KG
		PU-238	4.0	7.9		12.21	BQ/KG
		PU-238	8.0	11.8		151.70	BQ/KG
		PU-238	11.9	15.7		0.33	BQ/KG
		PU-239	0.1	3.9		45.88	BQ/KG
		PU-239	4.0	7.9		88.80	BQ/KG
		PU-239	8.0	11.8		2553.00	BQ/KG
		PU-239	11.9	15.7		32.93	BQ/KG
		SR-89	.	.	K	2960.00	BQ/KG
		SR-89	0.1	3.9		111.00	BQ/KG
		SR-89	4.0	7.9		148.00	BQ/KG
		SR-89	8.0	11.8	M	4292.00	BQ/KG
		SR-89	11.9	15.7	M	1258.00	BQ/KG
		SR-90	.	.		29600.00	BQ/KG
		SR-90	0.1	3.9		74.00	BQ/KG
		SR-90	4.0	7.9		74.00	BQ/KG
		SR-90	8.0	11.8		20831.00	BQ/KG
		SR-90	11.9	15.7		5661.00	BQ/KG
		TL-208	11.9	15.7		22.20	BQ/KG

Table B2 (continued)

Sample Site(mi)	Type of Analysis	Compound	Upper Depth(in)	Lower Depth(in)	Qualifier	Value	Units
WOC 0.38	METAL	ARSENIC	.	.		12.00	MG/KG
		CADMIUM	.	.		1.10	MG/KG
		CHROMIUM	.	.		96.00	MG/KG
		CYANIDE	.	.	U	1.00	MG/KG
		LEAD	.	.		33.00	MG/KG
		MERCURY	.	.	A	2.20	MG/KG
		NICKEL	.	.		25.00	MG/KG
		SILVER	.	.		2.00	MG/KG
		URANIUM	.	.		1.60	MG/KG
		URANIUM	0.1	3.3		0.30	MG/KG
		URANIUM	3.4	6.7		11.00	MG/KG
		URANIUM	6.8	9.6		7.00	MG/KG
		URANIUM	9.7	13.4		3.70	MG/KG
		ZIRCONIUM	.	.		280.00	MG/KG
WOC 0.38	ORGANIC	ACENAPHTHENE	.	.	U	0.63	MG/KG
		ACENAPHTHYLENE	.	.	U	0.63	MG/KG
		ANTHRACENE	.	.	U	0.63	MG/KG
		BENZIDINE	.	.	U	3.20	MG/KG
		BENZO(A)ANTHRACENE	.	.	U	0.63	MG/KG
		BENZO(B)FLUORANTHENE	.	.	U	0.63	MG/KG
		BENZO(GHI)PERYLENE	.	.	U	0.63	MG/KG
		BENZO(K)FLUORANTHENE	.	.	U	0.63	MG/KG
		BENZO-A-PYRENE	.	.	U	0.63	MG/KG
		BIS (2-CHLOROETHOXY) METHANE	.	.	U	0.63	MG/KG
		BIS (2-CHLOROETHYL) ETHER	.	.	U	0.63	MG/KG
		BIS (2-CHLOROISOPROPYL) ETHER	.	.	U	0.63	MG/KG
		BIS (2-ETHYLHEXYL) PHTHALATE	.	.	U	0.63	MG/KG
		CHRYSENE	.	.	U	0.63	MG/KG
		DI-N-BUTYL PHTHALATE	.	.	U	0.63	MG/KG
		DI-N-OCTYL PHTHALATE	.	.	U	0.63	MG/KG
		DIETHYL PHTHALATE	.	.	U	0.63	MG/KG
		DIMETHYL PHTHALATE	.	.	U	0.63	MG/KG
		FLUORANTHENE	.	.	U	0.63	MG/KG
		FLUORENE	.	.	U	0.63	MG/KG
		HEXACHLOROBENZENE	.	.	U	0.63	MG/KG
		HEXACHLOROBUTADIENE	.	.	U	0.63	MG/KG
		HEXACHLOROCYCLOPENTADIENE	.	.	U	0.63	MG/KG
		HEXACHLOROETHANE	.	.	U	0.63	MG/KG
		INDENO (1,2,3-CD) PYRENE	.	.	U	0.63	MG/KG
		ISOPHORONE	.	.	U	0.63	MG/KG
		N-BUTYL BENZYL PHTHALATE	.	.	U	0.63	MG/KG
		N-NITROSODI-N-PROPYLAMINE	.	.	U	0.63	MG/KG
		N-NITROSODIMETHYLAMINE	.	.	U	0.63	MG/KG
		N-NITROSODIPHENYLAMINE	.	.	U	0.63	MG/KG
		NAPHTHALENE	.	.	U	0.63	MG/KG
		NITROBENZENE	.	.	U	0.63	MG/KG
		PCB-1016	.	.	U	0.10	MG/KG
		PCB-1221	.	.	U	0.10	MG/KG
		PCB-1232	.	.	U	0.10	MG/KG
		PCB-1242	.	.	U	0.10	MG/KG
		PCB-1248	.	.	U	0.10	MG/KG
		PCB-1254	.	.	U	0.10	MG/KG
		PCB-1260	.	.	U	0.10	MG/KG
		PHENANTHRENE	.	.	U	0.63	MG/KG
		PHENOLS	.	.	U	0.40	MG/KG
		PYRENE	.	.	U	0.63	MG/KG
		1,2-DICHLOROBENZENE	.	.	U	0.63	MG/KG
		1,2-DIPHENYLHYDRAZINE	.	.	U	0.63	MG/KG
		1,2,4-TRICHLOROBENZENE	.	.	U	0.63	MG/KG
		1,2,5,6-DIBENZANTHRACENE	.	.	U	0.63	MG/KG
		1,3-DICHLOROBENZENE	.	.	U	0.63	MG/KG
		1,4-DICHLOROBENZENE	.	.	U	0.63	MG/KG
		2-CHLORONAPHTHALENE	.	.	U	0.63	MG/KG
		2,4-DINITROTOLUENE	.	.	U	0.63	MG/KG
		2,6-DINITROTOLUENE	.	.	U	0.63	MG/KG
		3,3'-DICHLOROBENZIDINE	.	.	U	1.60	MG/KG
		4-BROMOPHENYL PHENYL ETHER	.	.	U	0.63	MG/KG
		4-CHLOROPHENYL PHENYL ETHER	.	.	U	0.63	MG/KG

Table B2 (continued)

Sample Site(mi)	Type of Analysis	Compound	Upper Depth(in)	Lower Depth(in)	Qualifier	Value	Units
WOC 0.38	RADIO-NUCLIDES	AC-228	.	.		66.60	BQ/KG
		AC-228	0.1	3.3		51.80	BQ/KG
		AC-228	3.4	6.7		148.00	BQ/KG
		AC-228	6.8	9.6		74.00	BQ/KG
		AC-228	9.7	13.4		66.60	BQ/KG
		AM-241	.	.		15.91	BQ/KG
		AM-241	3.4	6.7		481.00	BQ/KG
		BI-212	9.7	13.4		111.00	BQ/KG
		BI-214	6.8	9.6		40.70	BQ/KG
		BI-214	9.7	13.4		62.90	BQ/KG
		CO-60	.	.		2849.00	BQ/KG
		CO-60	0.1	3.3		2035.00	BQ/KG
		CO-60	3.4	6.7		10286.00	BQ/KG
		CO-60	6.8	9.6		4033.00	BQ/KG
		CO-60	9.7	13.4		629.00	BQ/KG
		CS-134	.	.		7.40	BQ/KG
		CS-134	.	.		25.90	BQ/KG
		CS-134	0.1	3.3		14.80	BQ/KG
		CS-134	0.1	3.3		18.50	BQ/KG
		CS-137	.	.		152477.00	BQ/KG
		CS-137	0.1	3.3		58941.00	BQ/KG
		CS-137	3.4	6.7		773485.00	BQ/KG
		CS-137	6.8	9.6		203759.00	BQ/KG
		CS-137	9.7	13.4		10249.00	BQ/KG
		CM-244	.	.		0.52	BQ/KG
		EU-152	0.1	3.3		48.10	BQ/KG
		EU-154	.	.		66.60	BQ/KG
		EU-154	0.1	3.3		40.70	BQ/KG
		EU-154	3.4	6.7		185.00	BQ/KG
		EU-154	6.8	9.6		25.90	BQ/KG
		PB-212	0.1	3.3		37.00	BQ/KG
		PB-212	3.4	6.7		148.00	BQ/KG
		PB-212	6.8	9.6		74.00	BQ/KG
		PB-212	9.7	13.4		59.20	BQ/KG
		PU-238	.	.		0.26	BQ/KG
		PU-239	.	.		37.74	BQ/KG
		SR-89	.	.	M	259.00	BQ/KG
		SR-89	0.1	3.3	M	111.00	BQ/KG
		SR-89	3.4	6.7	M	6327.00	BQ/KG
		SR-89	6.8	9.6	M	3367.00	BQ/KG
		SR-89	9.7	13.4		444.00	BQ/KG
		SR-90	.	.		999.00	BQ/KG
		SR-90	0.1	3.3		444.00	BQ/KG
		SR-90	3.4	6.7		20054.00	BQ/KG
		SR-90	6.8	9.6		9879.00	BQ/KG
		SR-90	9.7	13.4		259.00	BQ/KG
		TL-208	9.7	13.4		29.60	BQ/KG
WOC 0.51	METAL	URANIUM	0.1	4.9		0.70	MG/KG
		URANIUM	0.1	4.9		3.40	MG/KG
		URANIUM	5.0	9.8		3.00	MG/KG
		URANIUM	5.0	9.8		6.00	MG/KG
		URANIUM	9.9	14.8		6.80	MG/KG
		URANIUM	9.9	14.8		8.00	MG/KG
		URANIUM	14.9	19.7		4.50	MG/KG
		URANIUM	14.9	19.7		7.00	MG/KG
WOC 0.51	RADIO-NUCLIDES	AC-228	0.1	4.9		74.00	BQ/KG
		AC-228	0.1	4.9		92.50	BQ/KG
		AC-228	5.0	9.8		148.00	BQ/KG
		AC-228	5.0	9.8		259.00	BQ/KG
		AC-228	9.9	14.8		148.00	BQ/KG
		AC-228	9.9	14.8		148.00	BQ/KG
		AC-228	14.9	19.7		55.50	BQ/KG
		AC-228	14.9	19.7		62.90	BQ/KG
		AM-241	0.1	4.9		370.00	BQ/KG
		AM-241	0.1	4.9		2701.00	BQ/KG
		AM-241	5.0	9.8		444.00	BQ/KG
		AM-241	5.0	9.8		703.00	BQ/KG

Table B2 (continued)

Sample Site(mi)	Type of Analysis	Compound	Upper Depth(in)	Lower Depth(in)	Qualifier	Value	Units
WOC 0.51	RADIO-NUCLIDES	BI-212	14.9	19.7		111.00	BQ/KG
		BI-214	0.1	4.9		51.80	BQ/KG
		BI-214	5.0	9.8		37.00	BQ/KG
		BI-214	5.0	9.8		48.10	BQ/KG
		BI-214	9.9	14.8		55.50	BQ/KG
		BI-214	9.9	14.8		59.20	BQ/KG
		BI-214	14.9	19.7		40.70	BQ/KG
		BI-214	14.9	19.7		48.10	BQ/KG
		CO-60	0.1	4.9		4366.00	BQ/KG
		CO-60	0.1	4.9		4477.00	BQ/KG
		CO-60	5.0	9.8		5661.00	BQ/KG
		CO-60	5.0	9.8		6512.00	BQ/KG
		CO-60	9.9	14.8		4921.00	BQ/KG
		CO-60	9.9	14.8		6290.00	BQ/KG
		CO-60	14.9	19.7		444.00	BQ/KG
		CO-60	14.9	19.7		555.00	BQ/KG
		CS-134	0.1	4.9		14.80	BQ/KG
		CS-134	0.1	4.9		18.50	BQ/KG
		CS-134	0.1	4.9		33.30	BQ/KG
		CS-134	0.1	4.9		33.30	BQ/KG
		CS-137	0.1	4.9		160099.00	BQ/KG
		CS-137	0.1	4.9		319791.00	BQ/KG
		CS-137	5.0	9.8		702630.00	BQ/KG
		CS-137	5.0	9.8		969659.00	BQ/KG
		CS-137	9.9	14.8		314167.00	BQ/KG
		CS-137	9.9	14.8		468346.00	BQ/KG
		CS-137	14.9	19.7		12876.00	BQ/KG
		CS-137	14.9	19.7		20646.00	BQ/KG
		EU-152	0.1	4.9		259.00	BQ/KG
		EU-154	0.1	4.9		407.00	BQ/KG
		EU-154	0.1	4.9		481.00	BQ/KG
		EU-154	5.0	9.8		92.50	BQ/KG
		EU-154	5.0	9.8		333.00	BQ/KG
		EU-154	9.9	14.8		44.40	BQ/KG
		EU-154	9.9	14.8		55.50	BQ/KG
		PB-212	0.1	4.9		74.00	BQ/KG
		PB-212	5.0	9.8		148.00	BQ/KG
		PB-212	5.0	9.8		185.00	BQ/KG
		PB-212	9.9	14.8		81.40	BQ/KG
		PB-212	9.9	14.8		111.00	BQ/KG
		PB-212	14.9	19.7		44.40	BQ/KG
		PB-212	14.9	19.7		51.80	BQ/KG
		PB-214	14.9	19.7		37.00	BQ/KG
		PB-214	14.9	19.7		51.80	BQ/KG
		SR-89	0.1	4.9	M	296.00	BQ/KG
		SR-89	0.1	4.9	M	370.00	BQ/KG
		SR-89	5.0	9.8	M	1443.00	BQ/KG
		SR-89	5.0	9.8	M	2849.00	BQ/KG
		SR-89	9.9	14.8	M	1073.00	BQ/KG
		SR-89	9.9	14.8	M	1147.00	BQ/KG
		SR-89	14.9	19.7	M	962.00	BQ/KG
		SR-89	14.9	19.7	M	1110.00	BQ/KG
		SR-90	0.1	4.9		1332.00	BQ/KG
		SR-90	0.1	4.9		2775.00	BQ/KG
		SR-90	5.0	9.8		4699.00	BQ/KG
		SR-90	5.0	9.8		9139.00	BQ/KG
		SR-90	9.9	14.8		8510.00	BQ/KG
		SR-90	9.9	14.8		10249.00	BQ/KG
		SR-90	14.9	19.7		2627.00	BQ/KG
		SR-90	14.9	19.7		4033.00	BQ/KG
		TL-208	9.9	14.8		51.80	BQ/KG
		TL-208	14.9	19.7		22.20	BQ/KG
		TL-208	14.9	19.7		25.90	BQ/KG

Table B2 (continued)

Sample Site(mi)	Type of Analysis	Compound	Upper Depth(in)	Lower Depth(in)	Qualifier	Value	Units
WOC 0.55	METAL	ARSENIC	.	.		5.00	MG/KG
		ARSENIC	.	.		5.00	MG/KG
		CADMIUM	.	.		2.20	MG/KG
		CADMIUM	.	.		2.60	MG/KG
		CHROMIUM	.	.		280.00	MG/KG
		CHROMIUM	.	.		290.00	MG/KG
		CYANIDE	.	.	U	1.00	MG/KG
		CYANIDE	.	.	U	1.00	MG/KG
		LEAD	.	.		38.00	MG/KG
		LEAD	.	.		39.00	MG/KG
		MERCURY	.	.	A	2.70	MG/KG
		MERCURY	.	.	A	2.70	MG/KG
		NICKEL	.	.		25.00	MG/KG
		NICKEL	.	.		25.00	MG/KG
		SILVER	.	.		9.00	MG/KG
		SILVER	.	.		10.00	MG/KG
		URANIUM	.	.		1.90	MG/KG
		URANIUM	0.1	3.1		3.40	MG/KG
		URANIUM	3.2	6.3		2.80	MG/KG
		URANIUM	6.4	9.4		2.70	MG/KG
		URANIUM	9.5	12.6		4.00	MG/KG
		ZIRCONIUM	.	.		420.00	MG/KG
		ZIRCONIUM	.	.		450.00	MG/KG
WOC 0.55	ORGANIC	ACENAPHTHENE	.	.	U	0.82	MG/KG
		ACENAPHTHENE	.	.	U	0.82	MG/KG
		ACENAPHTHYLENE	.	.	U	0.82	MG/KG
		ACENAPHTHYLENE	.	.	U	0.82	MG/KG
		ANTHRACENE	.	.	U	0.82	MG/KG
		ANTHRACENE	.	.	U	0.82	MG/KG
		BENZIDINE	.	.	U	4.10	MG/KG
		BENZIDINE	.	.	U	4.10	MG/KG
		BENZO(A)ANTHRACENE	.	.	U	0.82	MG/KG
		BENZO(A)ANTHRACENE	.	.	U	0.82	MG/KG
		BENZO(B)FLUORANTHENE	.	.	U	0.82	MG/KG
		BENZO(B)FLUORANTHENE	.	.	U	0.82	MG/KG
		BENZO(GHI)PERYLENE	.	.	U	0.82	MG/KG
		BENZO(GHI)PERYLENE	.	.	U	0.82	MG/KG
		BENZO(K)FLUORANTHENE	.	.	U	0.82	MG/KG
		BENZO(K)FLUORANTHENE	.	.	U	0.82	MG/KG
		BENZO-A-PYRENE	.	.	U	0.82	MG/KG
		BENZO-A-PYRENE	.	.	U	0.82	MG/KG
		BIS (2-CHLOROETHOXY) METHANE	.	.	U	0.82	MG/KG
		BIS (2-CHLOROETHOXY) METHANE	.	.	U	0.82	MG/KG
		BIS (2-CHLOROETHYL) ETHER	.	.	U	0.82	MG/KG
		BIS (2-CHLOROETHYL) ETHER	.	.	U	0.82	MG/KG
		BIS (2-CHLOROISOPROPYL) ETHER	.	.	U	0.82	MG/KG
		BIS (2-CHLOROISOPROPYL) ETHER	.	.	U	0.82	MG/KG
		BIS (2-ETHYLHEXYL) PHTHALATE	.	.	U	0.82	MG/KG
		BIS (2-ETHYLHEXYL) PHTHALATE	.	.		1.60	MG/KG
		CHRYSENE	.	.	U	0.82	MG/KG
		CHRYSENE	.	.	U	0.82	MG/KG
		DI-N-BUTYL PHTHALATE	.	.	U	0.82	MG/KG
		DI-N-BUTYL PHTHALATE	.	.	U	0.82	MG/KG
		DI-N-OCTYL PHTHALATE	.	.	U	0.82	MG/KG
		DI-N-OCTYL PHTHALATE	.	.	U	0.82	MG/KG
		DIETHYL PHTHALATE	.	.	U	0.82	MG/KG
		DIETHYL PHTHALATE	.	.	U	0.82	MG/KG
		DIMETHYL PHTHALATE	.	.	U	0.82	MG/KG
		DIMETHYL PHTHALATE	.	.	U	0.82	MG/KG
		FLUORANTHENE	.	.	U	0.82	MG/KG
		FLUORANTHENE	.	.	U	0.82	MG/KG
		FLUORENE	.	.	U	0.82	MG/KG
		FLUORENE	.	.	U	0.82	MG/KG
		HEXACHLOROBENZENE	.	.	U	0.82	MG/KG
		HEXACHLOROBENZENE	.	.	U	0.82	MG/KG
		HEXACHLOROBUTADIENE	.	.	U	0.82	MG/KG
		HEXACHLOROBUTADIENE	.	.	U	0.82	MG/KG

Table B2 (continued)

Sample Site(mi)	Type of Analysis	Compound	Upper Depth(in)	Lower Depth(in)	Qualifier	Value	Units
WOC 0.55	ORGANIC	HEXACHLOROCYCLOPENTADIENE	.	.	U	0.82	MG/KG
		HEXACHLOROCYCLOPENTADIENE	.	.	U	0.82	MG/KG
		HEXACHLOROETHANE	.	.	U	0.82	MG/KG
		HEXACHLOROETHANE	.	.	U	0.82	MG/KG
		INDENO (1,2,3-CD) PYRENE	.	.	U	0.82	MG/KG
		INDENO (1,2,3-CD) PYRENE	.	.	U	0.82	MG/KG
		ISOPHORONE	.	.	U	0.82	MG/KG
		ISOPHORONE	.	.	U	0.82	MG/KG
		N-BUTYL BENZYL PHTHALATE	.	.	U	0.82	MG/KG
		N-BUTYL BENZYL PHTHALATE	.	.	U	0.82	MG/KG
		N-NITROSODI-N-PROPYLAMINE	.	.	U	0.82	MG/KG
		N-NITROSODI-N-PROPYLAMINE	.	.	U	0.82	MG/KG
		N-NITROSODIMETHYLAMINE	.	.	U	0.82	MG/KG
		N-NITROSODIMETHYLAMINE	.	.	U	0.82	MG/KG
		N-NITROSODIPHENYLAMINE	.	.	U	0.82	MG/KG
		N-NITROSODIPHENYLAMINE	.	.	U	0.82	MG/KG
		NAPHTHALENE	.	.	U	0.82	MG/KG
		NAPHTHALENE	.	.	U	0.82	MG/KG
		NITROBENZENE	.	.	U	0.82	MG/KG
		NITROBENZENE	.	.	U	0.82	MG/KG
		PCB-1016	.	.	U	0.10	MG/KG
		PCB-1016	.	.	U	0.10	MG/KG
		PCB-1221	.	.	U	0.10	MG/KG
		PCB-1221	.	.	U	0.10	MG/KG
		PCB-1232	.	.	U	0.10	MG/KG
		PCB-1232	.	.	U	0.10	MG/KG
		PCB-1242	.	.	U	0.10	MG/KG
		PCB-1242	.	.	U	0.10	MG/KG
		PCB-1248	.	.	U	0.10	MG/KG
		PCB-1248	.	.	U	0.10	MG/KG
		PCB-1254	.	.	U	0.10	MG/KG
		PCB-1254	.	.	U	0.10	MG/KG
		PCB-1260	.	.	U	0.10	MG/KG
		PCB-1260	.	.	U	0.10	MG/KG
		PHENANTHRENE	.	.	U	0.82	MG/KG
		PHENANTHRENE	.	.	U	0.82	MG/KG
		PHENOLS	.	.	U	0.40	MG/KG
		PHENOLS	.	.	U	0.40	MG/KG
		PYRENE	.	.	U	0.82	MG/KG
		PYRENE	.	.	U	0.82	MG/KG
		1,2-DICHLOROBENZENE	.	.	U	0.82	MG/KG
		1,2-DICHLOROBENZENE	.	.	U	0.82	MG/KG
		1,2-DIPHENYLHYDRAZINE	.	.	U	0.82	MG/KG
		1,2-DIPHENYLHYDRAZINE	.	.	U	0.82	MG/KG
		1,2,4-TRICHLOROBENZENE	.	.	U	0.82	MG/KG
		1,2,4-TRICHLOROBENZENE	.	.	U	0.82	MG/KG
		1,2,5,6-DIBENZANTHRACENE	.	.	U	0.82	MG/KG
		1,2,5,6-DIBENZANTHRACENE	.	.	U	0.82	MG/KG
		1,3-DICHLOROBENZENE	.	.	U	0.82	MG/KG
		1,3-DICHLOROBENZENE	.	.	U	0.82	MG/KG
		1,4-DICHLOROBENZENE	.	.	U	0.82	MG/KG
		1,4-DICHLOROBENZENE	.	.	U	0.82	MG/KG
		2-CHLORONAPHTHALENE	.	.	U	0.82	MG/KG
		2-CHLORONAPHTHALENE	.	.	U	0.82	MG/KG
		2,4-DINITROTOLUENE	.	.	U	0.82	MG/KG
		2,4-DINITROTOLUENE	.	.	U	0.82	MG/KG
		2,6-DINITROTOLUENE	.	.	U	0.82	MG/KG
		2,6-DINITROTOLUENE	.	.	U	0.82	MG/KG
		3,3'-DICHLOROBENZIDINE	.	.	U	2.10	MG/KG
		3,3'-DICHLOROBENZIDINE	.	.	U	2.10	MG/KG
		4-BROMOPHENYL PHENYL ETHER	.	.	U	0.82	MG/KG
		4-BROMOPHENYL PHENYL ETHER	.	.	U	0.82	MG/KG
		4-CHLOROPHENYL PHENYL ETHER	.	.	U	0.82	MG/KG
		4-CHLOROPHENYL PHENYL ETHER	.	.	U	0.82	MG/KG

Table B2 (continued)

Sample Site(mi)	Type of Analysis	Compound	Upper Depth(in)	Lower Depth(in)	Qualifier	Value	Units
WOC 0.55	RADIO-NUCLIDES	AC-228	3.2	6.3		51.80	BQ/KG
		AC-228	6.4	9.4		40.70	BQ/KG
		AC-228	9.5	12.6		51.80	BQ/KG
		AM-241	.	.		148.00	BQ/KG
		AM-241	0.1	3.1		199.80	BQ/KG
		AM-241	3.2	6.3		133.20	BQ/KG
		AM-241	6.4	9.4		59.20	BQ/KG
		AM-241	9.5	12.6		24.79	BQ/KG
		BI-214	.	.		22.20	BQ/KG
		BI-214	6.4	9.4		40.70	BQ/KG
		BI-214	9.5	12.6		33.30	BQ/KG
		CO-60	.	.		4810.00	BQ/KG
		CO-60	0.1	3.1		5920.00	BQ/KG
		CO-60	3.2	6.3		4366.00	BQ/KG
		CO-60	6.4	9.4		1443.00	BQ/KG
		CO-60	9.5	12.6		592.00	BQ/KG
		CS-134	.	.		7.40	BQ/KG
		CS-134	.	.		44.40	BQ/KG
		CS-134	0.1	3.1		14.80	BQ/KG
		CS-134	0.1	3.1		48.10	BQ/KG
		CS-134	3.2	6.3		11.10	BQ/KG
		CS-134	3.2	6.3		33.30	BQ/KG
		CS-137	.	.		40145.00	BQ/KG
		CS-137	0.1	3.1		44807.00	BQ/KG
		CS-137	3.2	6.3		54057.00	BQ/KG
		CS-137	6.4	9.4		37333.00	BQ/KG
		CS-137	9.5	12.6		6956.00	BQ/KG
		CM-244	0.1	3.1		444.00	BQ/KG
		CM-244	3.2	6.3		236.80	BQ/KG
		CM-244	6.4	9.4		70.30	BQ/KG
		CM-244	9.5	12.6		43.66	BQ/KG
		EU-152	.	.		296.00	BQ/KG
		EU-152	0.1	3.1		329.30	BQ/KG
		EU-152	3.2	6.3		236.80	BQ/KG
		EU-152	6.4	9.4		88.80	BQ/KG
		EU-154	.	.		259.00	BQ/KG
		EU-154	0.1	3.1		329.30	BQ/KG
		EU-154	3.2	6.3		296.00	BQ/KG
		EU-154	6.4	9.4		133.20	BQ/KG
		EU-154	9.5	12.6		19.98	BQ/KG
		PB-212	.	.		40.70	BQ/KG
		PB-212	0.1	3.1		44.40	BQ/KG
		PB-212	3.2	6.3		44.40	BQ/KG
		PB-212	6.4	9.4		40.70	BQ/KG
		PB-212	9.5	12.6		44.40	BQ/KG
		PB-214	6.4	9.4		40.70	BQ/KG
		PB-214	9.5	12.6		40.70	BQ/KG
		PU-238	0.1	3.1		17.02	BQ/KG
		PU-238	3.2	6.3		13.32	BQ/KG
		PU-238	6.4	9.4		8.14	BQ/KG
		PU-238	9.5	12.6		1.33	BQ/KG
		PU-239	0.1	3.1		85.10	BQ/KG
		PU-239	3.2	6.3		88.80	BQ/KG
		PU-239	6.4	9.4		70.30	BQ/KG
		PU-239	9.5	12.6		13.32	BQ/KG
		SR-89	.	.	M	148.00	BQ/KG
		SR-89	0.1	3.1	M	11.10	BQ/KG
		SR-89	3.2	6.3	M	111.00	BQ/KG
		SR-89	6.4	9.4	M	37.00	BQ/KG
		SR-89	9.5	12.6	M	74.00	BQ/KG
		SR-90	.	.		629.00	BQ/KG
		SR-90	0.1	3.1		666.00	BQ/KG
		SR-90	3.2	6.3		444.00	BQ/KG
		SR-90	6.4	9.4		407.00	BQ/KG
		SR-90	9.5	12.6		222.00	BQ/KG
		TH-234	9.5	12.6		74.00	BQ/KG
		TL-208	.	.		14.80	BQ/KG
		TL-208	9.5	12.6		17.39	BQ/KG

U,K = less than detection limit, A=duplicate samples averaged, M=presence verified but not quantified
Repeat of upper and lower depths for an analysis indicates duplicate samples.

Appendix C

CONCENTRATIONS OF INORGANIC AND ORGANIC CONTAMINANTS IN WHITE OAK CREEK EMBAYMENT CORE SAMPLES COLLECTED IN 1990

Table C1. Summary of inorganic and organic contaminant concentrations in White Oak Creek Embayment core samples collected in 1990[a].

Analysis Type	Compound	Number	Min Qual[b]	Minimum Value	Max Qual	Maximum Value	Mean Value	Standard Deviation	Units
METALS	ANTIMONY	11	UJ	8.600	J	14.40	9.71	1.67	MG/KG
	ARSENIC	23	J	0.030	J	7.60	4.09	1.67	MG/KG
	BERYLLIUM	23	V/V	0.730	V/V	2.80	1.57	0.77	MG/KG
	CADMIUM	23	V/V	1.000	V/V	4.40	2.51	1.04	MG/KG
	CHROMIUM	23	V/V	24.000	V/V	101.00	57.08	32.27	MG/KG
	COPPER	23	V/V	13.000	V/V	43.20	25.32	12.29	MG/KG
	LEAD	23	J	13.900	V/V	138.00	66.11	45.86	MG/KG
	MERCURY	18	U	0.120	J	360.00	81.37	96.24	MG/KG
	NICKEL	23	V/V	17.900	V/V	30.10	23.53	3.27	MG/KG
	SELENIUM	23	UJ	0.000	UJ	0.70	0.53	0.23	MG/KG
	SILVER	23	U	2.900	V/V	18.40	8.41	6.75	MG/KG
	THALLIUM	22	U	0.280	V/V	0.78	0.63	0.10	MG/KG
	ZINC	23	V/V	51.600	V/V	123.00	80.25	24.95	MG/KG
ORGANICS	ACENAPHTHENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	ACENAPHTHYLENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	ALDRIN	25	UJ	0.013	UJ	0.15	0.12	0.03	MG/KG
	ALPHA-BHC	25	UJ	0.013	UJ	0.15	0.12	0.03	MG/KG
	ALPHA-CHLORDANE	25	UJ	0.110	UJ	1.50	1.22	0.26	MG/KG
	ANTHRACENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	AROCLOR-1016	25	UJ	0.110	UJ	1.50	1.22	0.26	MG/KG
	AROCLOR-1221	25	UJ	0.110	UJ	1.50	1.22	0.26	MG/KG
	AROCLOR-1232	25	UJ	0.110	UJ	1.50	1.22	0.26	MG/KG
	AROCLOR-1242	25	UJ	0.110	UJ	1.50	1.22	0.26	MG/KG
	AROCLOR-1248	25	UJ	0.110	UJ	1.50	1.22	0.26	MG/KG
	AROCLOR-1254	25	NJ	0.044	NJ	4.70	1.82	1.43	MG/KG
	AROCLOR-1260	25	UJ	0.220	UJ	2.90	2.45	0.51	MG/KG
	BENZO(A)ANTHRACENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	BENZO(A)PYRENE	26	J	0.320	UJ	6.10	2.43	2.37	MG/KG
	BENZO(B)FLUORANTHENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	BENZO(G,H,I)PERYLENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	BENZO(K)FLUORANTHENE	26	J	0.110	UJ	6.10	2.79	2.14	MG/KG
	BENZOIC ACID	26	UJ	4.500	UJ	29.00	13.73	10.17	MG/KG
	BENZYL ALCOHOL	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	BETA-BHC	25	UJ	0.013	UJ	0.15	0.12	0.03	MG/KG
	BIS(2-CHLOROETHOXY)METHANE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	BIS(2-CHLOROETHYL)ETHER	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	BIS(2-CHLOROISOPROPYL)ETHER	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	BIS(2-ETHYLHEXYL)PHTHALATE	26	J	0.330	UJ	6.10	2.56	2.12	MG/KG
	BUTYLBENZYLPHTHALATE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	CHRYSENE	26	J	0.120	UJ	6.10	2.65	2.28	MG/KG
	DELTA-BHC	25	UJ	0.013	UJ	0.15	0.12	0.03	MG/KG
	DI-N-BUTYLPHTHALATE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	DI-N-OCTYLPHTHALATE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	DIBENZ(A,H)ANTHRACENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	DIBENZOFURAN	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	DIELDRIN	25	UJ	0.022	UJ	0.29	0.25	0.05	MG/KG
	DIETHYLPHTHALATE	26	J	0.140	UJ	6.10	2.79	2.14	MG/KG
	DIMETHYLPHTHALATE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	ENDOSULFAN I	25	UJ	0.013	UJ	0.15	0.12	0.03	MG/KG
	ENDOSULFAN II	25	UJ	0.022	UJ	0.29	0.25	0.05	MG/KG
	ENDOSULFAN SULFATE	25	UJ	0.022	UJ	0.29	0.25	0.05	MG/KG
	ENDRIN	25	UJ	0.022	UJ	0.29	0.25	0.05	MG/KG
	ENDRIN KETONE	25	UJ	0.022	UJ	0.29	0.25	0.05	MG/KG
	FLUORANTHENE	26	J	0.140	UJ	6.10	2.66	2.27	MG/KG
	FLUORENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	GAMMA-BHC (LINDANE)	25	UJ	0.013	UJ	0.15	0.12	0.03	MG/KG
	GAMMA-CHLORDANE	25	UJ	0.110	UJ	1.50	1.22	0.26	MG/KG
	HEPTACHLOR	25	UJ	0.013	UJ	0.15	0.12	0.03	MG/KG
	HEPTACHLOR EPOXIDE	25	UJ	0.013	UJ	0.15	0.12	0.03	MG/KG
	HEXACHLOROBENZENE	26	UJ	0.920	UJ	9.50	3.11	2.47	MG/KG
	HEXACHLOROBUTADIENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	HEXACHLOROCYCLOPENTADIENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	HEXACHLOROETHANE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	INDENO(1,2,3-CD)PYRENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	ISOPHORONE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	METHOXYCHLOR	25	UJ	0.110	UJ	1.50	1.22	0.26	MG/KG
	N-NITROSO-DI-N-PROPYLAMINE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG

Table C1 (continued)

Analysis Type	Compound	Number	Min Qual	Minimum Value	Max Qual	Maximum Value	Mean Value	Standard Deviation	Units
ORGANICS	N-NITROSODIPHENYLAMINE	26	UJ	0.920	UJ	9.50	3.11	2.47	MG/KG
	NAPHTHALENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	NITROBENZENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	PENTACHLOROPHENOL	26	UJ	4.500	UJ	29.00	13.73	10.17	MG/KG
	PHENANTHRENE	26	J	0.140	UJ	6.10	2.66	2.27	MG/KG
	PHENOL	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	PYRENE	26	J	0.100	UJ	6.10	2.59	2.33	MG/KG
	TOXAPHENE	25	UJ	0.220	UJ	2.90	2.45	0.51	MG/KG
	1,2-DICHLOROBENZENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	1,2,4-TRICHLOROBENZENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	1,3-DICHLOROBENZENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	1,4-DICHLOROBENZENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	2-CHLORONAPHTHALENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	2-CHLOROPHENOL	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	2-METHYLNAPHTHALENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	2-METHYLPHENOL	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	2-NITROANILINE	26	UJ	4.500	UJ	29.00	13.73	10.17	MG/KG
	2-NITROPHENOL	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	2,4-DICHLOROPHENOL	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	2,4-DIMETHYLPHENOL	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	2,4-DINITROPHENOL	26	UJ	4.500	UJ	29.00	13.73	10.17	MG/KG
	2,4-DINITROTOLUENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	2,4,5-TRICHLOROPHENOL	26	UJ	4.500	UJ	29.00	13.73	10.17	MG/KG
	2,4,6-TRICHLOROPHENOL	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	2,6-DINITROTOLUENE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	3-NITROANILINE	26	UJ	2.900	UJ	29.00	12.73	9.89	MG/KG
	3,3'-DICHLOROBENZIDINE	26	UJ	1.800	UJ	12.00	5.67	4.21	MG/KG
	4-BROMOPHENYL-PHENYLETHER	26	UJ	0.920	UJ	9.50	3.11	2.47	MG/KG
	4-CHLORO-3-METHYLPHENOL	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	4-CHLOROANILINE	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	4-CHLOROPHENYL-PHENYLETHER	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	4-METHYLPHENOL	26	UJ	0.920	UJ	6.10	2.82	2.10	MG/KG
	4-NITROANILINE	26	UJ	4.500	UJ	29.00	13.73	10.17	MG/KG
	4-NITROPHENOL	26	UJ	4.500	UJ	29.00	13.73	10.17	MG/KG
	4,4'-DDD	25	UJ	0.022	UJ	0.29	0.25	0.05	MG/KG
	4,4'-DDE	25	UJ	0.022	UJ	0.29	0.25	0.05	MG/KG
	4,4'-DDT	25	UJ	0.022	UJ	0.29	0.25	0.05	MG/KG
	4,6-DINITRO-2-METHYLPHENOL	26	UJ	4.500	UJ	29.00	13.73	10.17	MG/KG

[a]Core collected for metal analysis: 9400T
Core collected for organic analysis: 107000

[b]QUALIFIER CODES:

U = Compound was analyzed for but not detected.
J = Indicates an estimated value.
UJ = Compound was analyzed for but not detected and quantitation limit is an estimated value.
NJ = Tentative compound identification only and estimated concentration. No second column confirmation of pesticides.
V/V = Indicates that the result has been reviewed and is a valid result.

Table C2. Summary of inorganic and organic contaminant concentrations in WOCE core samples collected after July 1990[a].

Analysis Type	Compound	Number	Min Qual[b]	Minimum Value	Max Qual	Maximum Value	Mean Value	Standard Deviation	Units
METALS	ANTIMONY	66	UJ	0.19	J	17.10	2.45	4.86	MG/KG
	ARSENIC	69	J	0.30	V/V	17.40	4.73	2.79	MG/KG
	BERYLLIUM	69	V/V	0.35	V/V	2.50	0.98	0.41	MG/KG
	CADMIUM	64	J	0.10	V/V	4.40	0.97	1.17	MG/KG
	CHROMIUM	69	J	5.70	V/V	94.30	32.05	22.64	MG/KG
	COPPER	69	J	5.90	V/V	38.80	14.76	6.31	MG/KG
	LEAD	69	J	5.30	V/V	156.00	34.89	22.00	MG/KG
	MERCURY	69	U	0.02	V/V	62.50	3.25	9.71	MG/KG
	NICKEL	69	J	7.60	V/V	34.50	17.18	4.40	MG/KG
	SELENIUM	69	UJ	0.22	UJ	0.71	0.38	0.14	MG/KG
	SILVER	69	U	0.02	V/V	17.20	1.81	3.75	MG/KG
	THALLIUM	69	U	0.22	U	0.71	0.38	0.14	MG/KG
	ZINC	69	J	21.70	J	403.00	80.91	47.13	MG/KG
ORGANICS	ACENAPHTHENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	ACENAPHTHYLENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	ALDRIN	40	UJ	0.01	U	0.08	0.02	0.02	MG/KG
	ALPHA-BHC	40	UJ	0.01	U	0.08	0.02	0.02	MG/KG
	ALPHA-CHLORDANE	40	UJ	0.10	U	0.80	0.21	0.21	MG/KG
	ANTHRACENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	AROCLOR-1016	40	UJ	0.10	U	0.80	0.21	0.21	MG/KG
	AROCLOR-1221	40	UJ	0.10	U	0.80	0.21	0.21	MG/KG
	AROCLOR-1232	40	UJ	0.10	U	0.80	0.21	0.21	MG/KG
	AROCLOR-1242	40	UJ	0.10	U	0.80	0.21	0.21	MG/KG
	AROCLOR-1248	40	UJ	0.10	U	0.80	0.21	0.21	MG/KG
	AROCLOR-1254	40	UJ	0.21	V/V	4.30	0.52	0.77	MG/KG
	AROCLOR-1260	40	V/V	0.14	U	1.60	0.41	0.43	MG/KG
	BENZO(A)ANTHRACENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	BENZO(A)PYRENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	BENZO(B)FLUORANTHENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	BENZO(G,H,I)PERYLENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	BENZO(K)FLUORANTHENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	BENZOIC ACID	42	J	0.12	U	32.00	12.73	8.11	MG/KG
	BENZYL ALCOHOL	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	BETA-BHC	40	UJ	0.01	U	0.08	0.02	0.02	MG/KG
	BIS(2-CHLOROETHOXY)METHANE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	BIS(2-CHLOROETHYL)ETHER	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	BIS(2-CHLOROISOPROPYL)ETHER	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	BIS(2-ETHYLHEXYL)PHTHALATE	42	J	0.12	U	6.60	2.39	1.83	MG/KG
	BUTYLBENZYLPHTHALATE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	CHRYSENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	DELTA-BHC	40	UJ	0.01	U	0.08	0.02	0.02	MG/KG
	DI-N-BUTYLPHTHALATE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	DI-N-OCTYLPHTHALATE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	DIBENZ(A,H)ANTHRACENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	DIBENZOFURAN	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	DIELDRIN	40	UJ	0.02	U	0.16	0.04	0.04	MG/KG
	DIETHYLPHTHALATE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	DIMETHYLPHTHALATE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	ENDOSULFAN I	40	UJ	0.01	U	0.08	0.02	0.02	MG/KG
	ENDOSULFAN II	40	UJ	0.02	U	0.16	0.04	0.04	MG/KG
	ENDOSULFAN SULFATE	40	UJ	0.02	U	0.16	0.04	0.04	MG/KG
	ENDRIN	40	UJ	0.02	U	0.16	0.04	0.04	MG/KG
	ENDRIN KETONE	40	UJ	0.02	U	0.16	0.04	0.04	MG/KG
	FLUORANTHENE	42	J	0.11	U	6.60	2.64	1.66	MG/KG
	FLUORENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	GAMMA-BHC (LINDANE)	40	UJ	0.01	U	0.08	0.02	0.02	MG/KG
	GAMMA-CHLORDANE	40	UJ	0.10	U	0.80	0.21	0.21	MG/KG
	HEPTACHLOR	40	UJ	0.01	U	0.08	0.02	0.02	MG/KG
	HEPTACHLOR EPOXIDE	40	UJ	0.01	U	0.08	0.02	0.02	MG/KG
	HEXACHLOROBENZENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	HEXACHLOROBUTADIENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	HEXACHLOROCYCLOPENTADIENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	HEXACHLOROETHANE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	INDENO(1,2,3-CD)PYRENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	ISOPHORONE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	METHOXYCHLOR	40	UJ	0.10	U	0.80	0.21	0.21	MG/KG
	N-NITROSO-DI-N-PROPYLAMINE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG

Table C2 (continued)

Analysis Type	Compound	Number	Min Qual	Minimum Value	Max Qual	Maximum Value	Mean Value	Standard Deviation	Units
ORGANICS	N-NITROSODIPHENYLAMINE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	NAPHTHALENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	NITROBENZENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	PENTACHLOROPHENOL	42	UJ	2.10	U	32.00	12.85	7.96	MG/KG
	PHENANTHRENE	42	J	0.34	U	6.60	2.61	1.67	MG/KG
	PHENOL	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	PYRENE	42	J	0.11	U	6.60	2.58	1.70	MG/KG
	TOXAPHENE	40	UJ	0.21	U	1.60	0.41	0.43	MG/KG
	1,2-DICHLOROBENZENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	1,2,4-TRICHLOROBENZENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	1,3-DICHLOROBENZENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	1,4-DICHLOROBENZENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	2-CHLORONAPHTHALENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	2-CHLOROPHENOL	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	2-METHYLNAPHTHALENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	2-METHYLPHENOL	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	2-NITROANILINE	42	UJ	2.10	U	32.00	12.85	7.96	MG/KG
	2-NITROPHENOL	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	2,4-DICHLOROPHENOL	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	2,4-DIMETHYLPHENOL	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	2,4-DINITROPHENOL	42	UJ	2.10	U	32.00	12.85	7.96	MG/KG
	2,4-DINITROTOLUENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	2,4,5-TRICHLOROPHENOL	42	UJ	2.10	U	32.00	12.85	7.96	MG/KG
	2,4,6-TRICHLOROPHENOL	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	2,6-DINITROTOLUENE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	3-NITROANILINE	42	UJ	2.10	U	32.00	12.85	7.96	MG/KG
	3,3'-DICHLOROBENZIDINE	42	UJ	0.86	U	13.00	5.32	3.25	MG/KG
	4-BROMOPHENYL-PHENYLETHER	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	4-CHLORO-3-METHYLPHENOL	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	4-CHLOROANILINE	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	4-CHLOROPHENYL-PHENYLETHER	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	4-METHYLPHENOL	42	UJ	0.43	U	6.60	2.66	1.63	MG/KG
	4-NITROANILINE	42	UJ	2.10	U	32.00	12.85	7.96	MG/KG
	4-NITROPHENOL	42	UJ	2.10	U	32.00	12.85	7.96	MG/KG
	4,4'-DDD	40	UJ	0.02	U	0.16	0.04	0.04	MG/KG
	4,4'-DDE	40	UJ	0.02	U	0.16	0.04	0.04	MG/KG
	4,4'-DDT	40	UJ	0.02	U	0.16	0.04	0.04	MG/KG
	4,6-DINITRO-2-METHYLPHENOL	42	UJ	2.10	U	32.00	12.85	7.96	MG/KG

[a]Cores collected for metal analysis: 54100T, 54300T, 63500T
Cores collected for organic analysis: 553000, 555000

[b]QUALIFIER CODES:

U = Compound was analyzed for but not detected.
J = Indicates an estimated value.
UJ = Compound was analyzed for but not detected and quantitation limit is an estimated value.
NJ = Tentative compound identification only and estimated concentration. No second column confirmation of pesticides.
V/V = Indicates that the result has been reviewed and is a valid result.

Appendix D

CONCENTRATIONS OF RADIONUCLIDES IN WHITE OAK CREEK EMBAYMENT SURFACE SEDIMENT SAMPLES COLLECTED IN 1990

Table D1. Summary of radionuclide concentrations in WOCE grab samples

Analysis Type	Compound	Number	Minimum Qualifier*	Minimum Value	Maximum Qualifier	Maximum Value	Mean Value	Standard Deviation	Units
RAD	CO-60	75	J	10.68	J	6080.06	939.44	1029.99	BQ/KG
	CS-137	77	V/V	151.22	NOTV	1129569.94	100598.23	188749.70	BQ/KG
	EU-152	40	NOTV	36.32	NOTV	1072.93	237.58	200.18	BQ/KG
	EU-154	39	NOTV	12.77	NOTV	309.80	82.46	57.42	BQ/KG

*QUALIFIER CODES:

U = Compound was analyzed for but not detected.
J = Indicates an estimated value.
UJ = Compound was analyzed for but not detected and quantitation limit is an estimated value.
NJ = Tentative compound identification only and estimated concentration. No second column confirmation of pesticides.
V/V = Indicates that the result has been reviewed and is a valid result.
NOTV = Result has not been validated. Value corroborated by historical data and/or validated results for co-located samples and should be considered a reliable estimate.

Table D2. Radionuclide concentrations in WOCE grab samples

Sample ID	CO-60 Qualifier[a]	CO-60 Value	CS-137 Qualifier	CS-137 Value	Units
30200B	J	16.89	V/V	631.59	BQ/KG
30300B	U	.	V/V	151.22	BQ/KG
30400B	J	231.78	V/V	49364.68	BQ/KG
30500B	J	1021.51	V/V	444237.56	BQ/KG
30600B	J	761.76	V/V	285359.48	BQ/KG
30700B	J	173.27	V/V	9193.25	BQ/KG
30800B	J	705.22	V/V	270496.08	BQ/KG
30900B	J	169.69	V/V	8774.05	BQ/KG
31000B	J	1212.53	V/V	193469.88	BQ/KG
31100B	J	6080.06	V/V	587219.10	BQ/KG
31200B	J	366.96	V/V	22473.79	BQ/KG
31300B	J	30.13	V/V	1862.86	BQ/KG
31400B	J	231.75	V/V	15102.73	BQ/KG
31500B	J	196.20	V/V	10038.12	BQ/KG
31600B	J	1492.00	V/V	793163.38	BQ/KG
31700B	J	550.29	V/V	33452.05	BQ/KG
31800B	J	93.97	V/V	8552.58	BQ/KG
31900B	V/V	11.59	V/V	594.44	BQ/KG
32000B	J	18.91	V/V	783.71	BQ/KG
32100B	J	239.92	V/V	15563.23	BQ/KG
32200B	J	379.76	V/V	82316.51	BQ/KG
32300B	J	250.54	V/V	4604.26	BQ/KG
32400B	J	141.08	V/V	6280.44	BQ/KG
32500B	J	46.34	V/V	1196.21	BQ/KG
32600B	J	10.68	V/V	6529.41	BQ/KG
32700B	J	880.36	V/V	95095.40	BQ/KG
32800B	J	69.00	V/V	3138.93	BQ/KG
32900B	J	853.57	V/V	131210.68	BQ/KG
33000B	J	587.30	V/V	79481.48	BQ/KG
33100B	U	.	V/V	238444.44	BQ/KG
33200B	J	503.37	V/V	264162.79	BQ/KG
36900B	NOTV	124.37	NOTV	3132.07	BQ/KG
37000B	NOTV	929.58	NOTV	1129569.94	BQ/KG
37100B	NOTV	269.19	NOTV	9810.06	BQ/KG
37200B	NOTV	344.10	NOTV	18870.39	BQ/KG
37300B	NOTV	1741.13	NOTV	112169.20	BQ/KG
37400B	NOTV	1471.72	NOTV	91289.96	BQ/KG
37500B	NOTV	11.51	NOTV	322.54	BQ/KG
37600B	NOTV	1410.65	NOTV	76733.50	BQ/KG
37700B	NOTV	1461.28	NOTV	96961.11	BQ/KG
37800B	NOTV	640.03	NOTV	8819.16	BQ/KG
37900B	NOTV	1486.10	NOTV	79362.63	BQ/KG
38000B	NOTV	1510.22	NOTV	97373.79	BQ/KG
38100B	NOTV	155.46	NOTV	5442.34	BQ/KG
38200B	NOTV	779.88	NOTV	27835.30	BQ/KG
38300B	NOTV	536.48	NOTV	20256.79	BQ/KG
38400B	NOTV	1030.89	NOTV	55312.06	BQ/KG
38500B	NOTV	28.92	NOTV	908.66	BQ/KG
38600B	NOTV	773.51	NOTV	25770.28	BQ/KG
38700B	NOTV	333.55	NOTV	6602.58	BQ/KG
38800B	NOTV	945.26	NOTV	86609.54	BQ/KG
38900B	NOTV	742.36	NOTV	31796.73	BQ/KG
39000B	NOTV	589.61	NOTV	12582.06	BQ/KG
39100B	NOTV	862.09	NOTV	19209.01	BQ/KG
39200B	NOTV	866.93	NOTV	22642.64	BQ/KG
39300B	NOTV	1153.19	NOTV	62956.20	BQ/KG
39400B	NOTV	1094.28	NOTV	32556.73	BQ/KG
39500B	NOTV	981.92	NOTV	23550.50	BQ/KG
39600B	NOTV	1205.17	NOTV	31716.81	BQ/KG
39700B	NOTV	1287.14	NOTV	33202.49	BQ/KG
39800B	NOTV	830.03	NOTV	20655.22	BQ/KG
39900B	NOTV	1230.00	NOTV	22824.09	BQ/KG
40000B	NOTV	1474.39	NOTV	37125.88	BQ/KG
40100B	NOTV	1507.04	NOTV	84629.47	BQ/KG
40200B	NOTV	1100.73	NOTV	39687.96	BQ/KG
40300B	NOTV	1768.49	NOTV	78017.14	BQ/KG
40400B	NOTV	1589.90	NOTV	37835.54	BQ/KG
40500B	NOTV	1374.21	NOTV	26992.28	BQ/KG
40600B	J	975.00	V/V	20471.92	BQ/KG

Table D2 (continued)

Sample ID	CO-60 Qualifier	CO-60 Value	CS-137 Qualifier	CS-137 Value	Units
40700B	NOTV	585.87	NOTV	15411.10	BQ/KG
40800B	NOTV	1337.26	NOTV	63555.83	BQ/KG
40900B	NOTV	1493.23	NOTV	34242.73	BQ/KG
42600B	V/V	5093.43	V/V	481761.26	BQ/KG
42800B	V/V	1067.34	V/V	91077.39	BQ/KG
59300B	NOTV	401.47	NOTV	16169.18	BQ/KG
59400B	NOTV	4182.09	NOTV	505474.42	BQ/KG
59600B	NOTV	2354.71	NOTV	283822.60	BQ/KG

*QUALIFIER CODES:

U = Compound was analyzed for but not detected.
J = Indicates an estimated value.
UJ = Compound was analyzed for but not detected and quantitation limit is an estimated value.
NJ = Tentative compound identification only and estimated concentration. No second column confirmation of pesticides.
V/V = Indicates that the result has been reviewed and is a valid result.
NOTV = Result has not been validated. Value corroborated by historical data and/or validated results for co-located samples and should be considered a reliable estimate.

Table D3. Summary of radionuclide concentrations in WOCE core samples

Analysis Type	Compound	Number	Minimum Qualifier[a]	Minimum Value	Maximum Qualifier	Maximum Value	Mean Value	Standard Deviation	Units
RAD	AM-241	24	J	0.00	J	1272.80	288.29	376.73	BQ/KG
	CM-243,244	24	J	0.00	V/V	1.05	0.21	0.28	BQ/KG
	CM-245,246	7	V/V	0.26	V/V	4.99	2.06	2.04	BQ/KG
	CM-248	16	J	0.26	V/V	1.84	0.69	0.53	BQ/KG
	CO-60	519	UJ	0.00	J	7074.91	757.25	1571.67	BQ/KG
	CS-137	525	V/V	1.47	V/V	2186065.09	119992.53	261983.21	BQ/KG
	EU-152	266	U	8.10	U	1694.60	104.99	237.56	BQ/KG
	EU-154	75	U	2.51	U	520.56	72.66	103.03	BQ/KG
	PU-238	24	V/V	0.37	V/V	655.27	68.91	137.87	BQ/KG
	PU-239,240	24	V/V	31.08	J	11927.32	3059.81	3700.81	BQ/KG
	SR-90	24	J	836.94	J	42094.90	16459.94	15727.34	BQ/KG
	U-234	24	J	60.68	V/V	444.74	210.76	130.51	BQ/KG
	U-235	107	NOTV	0.74	U	1517.57	162.40	268.55	BQ/KG
	U-238	24	J	58.46	V/V	253.82	146.67	70.64	BQ/KG

[a]QUALIFIER CODES:

U = Compound was analyzed for but not detected.
J = Indicates an estimated value.
UJ = Compound was analyzed for but not detected and quantitation limit is an estimated value.
NJ = Tentative compound identification only and estimated concentration. No second column confirmation of pesticides.
V/V = Indicates that the result has been reviewed and is a valid result.
NOTV = Result has not been validated. Value corroborated by historical data and/or validated results for co-located samples and should be considered a reliable estimate.

Table D4. Summary of individual core radionuclide concentrations in WOCE

Core ID	Compound	Number	Mean Value	Units
10800G	CO-60	29	1716.37	BQ/KG
	CS-137	29	294496.59	BQ/KG
	EU-152	29	396.25	BQ/KG
	EU-154	28	100.91	BQ/KG
42700G	CO-60	27	1514.16	BQ/KG
	CS-137	27	229893.43	BQ/KG
	EU-152	27	347.00	BQ/KG
	EU-154	27	87.80	BQ/KG
42900G	CO-60	21	32.19	BQ/KG
	CS-137	21	13370.25	BQ/KG
	EU-152	21	42.01	BQ/KG
	EU-154	20	12.67	BQ/KG
54200G	CO-60	32	494.87	BQ/KG
	CS-137	32	70198.48	BQ/KG
	CO-60	32	889.87	BQ/KG
	CS-137	32	180653.56	BQ/KG
54500G	CO-60	14	6.30	BQ/KG
	CS-137	14	39.11	BQ/KG
	EU-152	15	26.53	BQ/KG
54600G	CO-60	18	8.87	BQ/KG
	CS-137	18	144.82	BQ/KG
54700G	CO-60	8	14.70	BQ/KG
	CS-137	8	12033.60	BQ/KG
	EU-152	10	20.92	BQ/KG
54800G	CO-60	18	180.34	BQ/KG
	CS-137	18	17339.62	BQ/KG
	EU-152	4	52.91	BQ/KG
54900G	CO-60	13	25.47	BQ/KG
	CS-137	13	55387.75	BQ/KG
55000G	CO-60	7	12.54	BQ/KG
	CS-137	7	12422.97	BQ/KG
	EU-152	9	29.62	BQ/KG
55100G	CO-60	12	8.83	BQ/KG
	CS-137	12	158.93	BQ/KG
	EU-152	14	26.60	BQ/KG
55200G	CO-60	14	8.46	BQ/KG
	CS-137	14	155.13	BQ/KG
	EU-152	16	23.18	BQ/KG
55400G	CO-60	22	1401.06	BQ/KG
	CS-137	22	203272.05	BQ/KG
55600G	CO-60	20	429.22	BQ/KG
	CS-137	20	62353.64	BQ/KG
57300G	CO-60	13	38.70	BQ/KG
	CS-137	13	2559.23	BQ/KG
	EU-152	15	29.24	BQ/KG
57400G	CO-60	19	71.52	BQ/KG
	CS-137	19	5133.20	BQ/KG
	EU-152	22	32.95	BQ/KG
57500G	CO-60	17	1485.05	BQ/KG
	CS-137	17	122057.86	BQ/KG
	U-235	18	411.12	BQ/KG
57600G	CO-60	9	13.28	BQ/KG
	CS-137	14	65251.89	BQ/KG
	U-235	15	326.76	BQ/KG
57700G	CO-60	17	266.95	BQ/KG
	CS-137	17	50654.29	BQ/KG
	U-235	18	261.73	BQ/KG
57800G	CO-60	8	5.94	BQ/KG
	CS-137	8	87.25	BQ/KG
	EU-152	10	26.00	BQ/KG
57900G	CO-60	8	7.90	BQ/KG
	CS-137	8	138.65	BQ/KG
	EU-152	10	26.83	BQ/KG
58000G	CO-60	10	7.61	BQ/KG
	CS-137	10	243.26	BQ/KG
	EU-152	12	24.37	BQ/KG
58100G	CO-60	7	10.84	BQ/KG
	CS-137	7	129.27	BQ/KG
	EU-152	9	27.15	BQ/KG

Table D4 (continued)

Core ID	Compound	Number	Mean Value	Units
58200G	CO-60	21	825.95	BQ/KG
	CS-137	21	103606.83	BQ/KG
	EU-152	23	64.60	BQ/KG
58300G	CO-60	18	1682.50	BQ/KG
	CS-137	18	188266.97	BQ/KG
58400G	CO-60	22	2116.07	BQ/KG
	CS-137	22	369981.54	BQ/KG
	EU-152	3	33.87	BQ/KG
58500G	CO-60	21	1096.18	BQ/KG
	CS-137	21	300250.93	BQ/KG
58600G	CO-60	13	94.56	BQ/KG
	CS-137	13	4021.03	BQ/KG
	EU-152	17	31.84	BQ/KG
63400G	CO-60	6	1180.19	BQ/KG
	CS-137	6	85948.81	BQ/KG
9500G	CO-60	23	2441.99	BQ/KG
	CS-137	24	351494.98	BQ/KG
9500R*	AM-241	24	288.29	BQ/KG
	CM-243,244	24	0.21	BQ/KG
	CM-245,246	7	2.06	BQ/KG
	CM-248	16	0.69	BQ/KG
	PU-238	24	68.91	BQ/KG
	PU-239,240	24	3059.81	BQ/KG
	SR-90	24	16459.94	BQ/KG
	U-234	24	210.76	BQ/KG
	U-235	56	6.49	BQ/KG
	U-238	24	146.67	BQ/KG

*Core 9500R was a resubmittal of 9500G

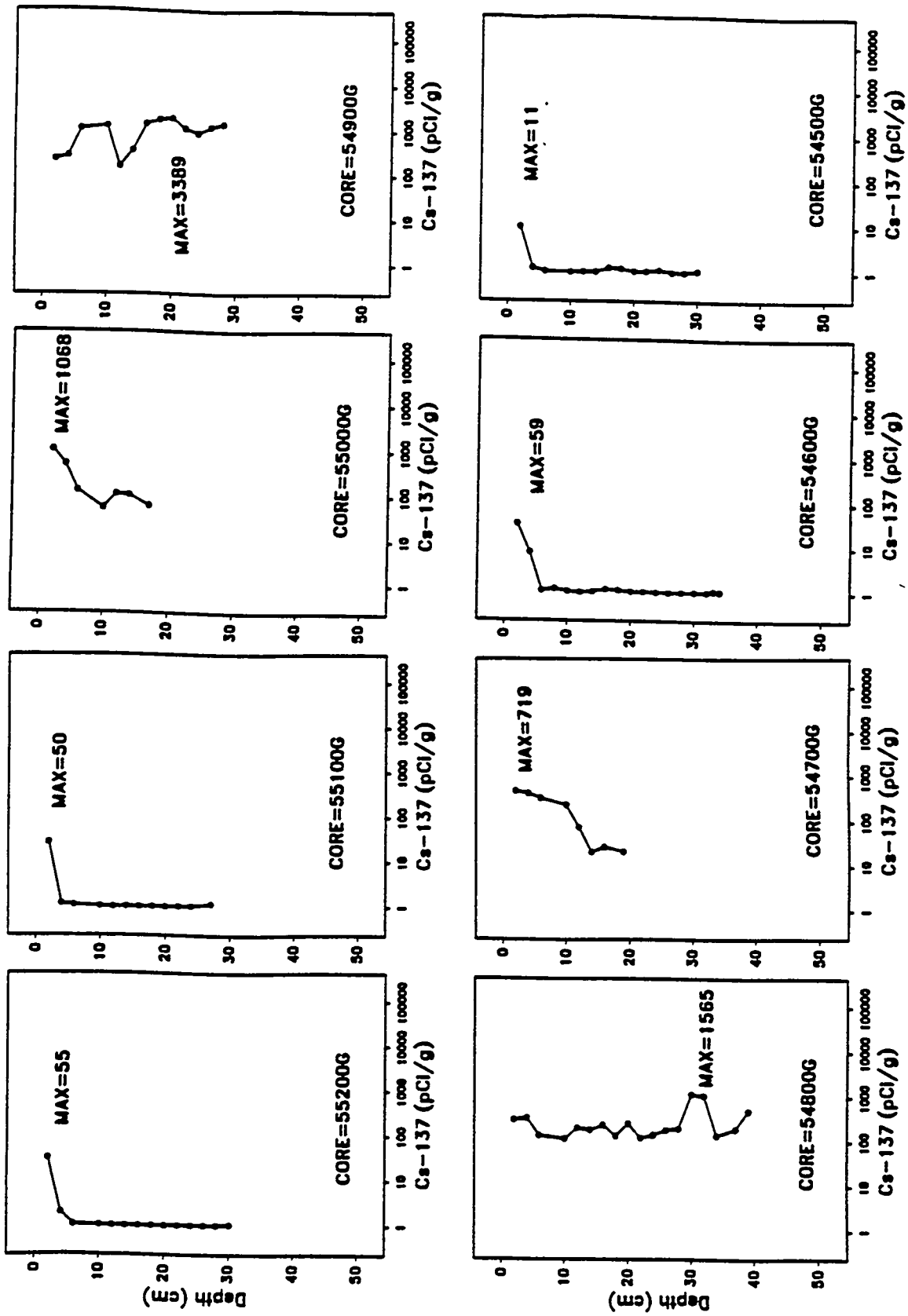

Fig. D1. Depth profiles for ^{137}Cs in sediment cores taken in transect across the mouth of WOCE (1 pCi = 0.037 Bq).

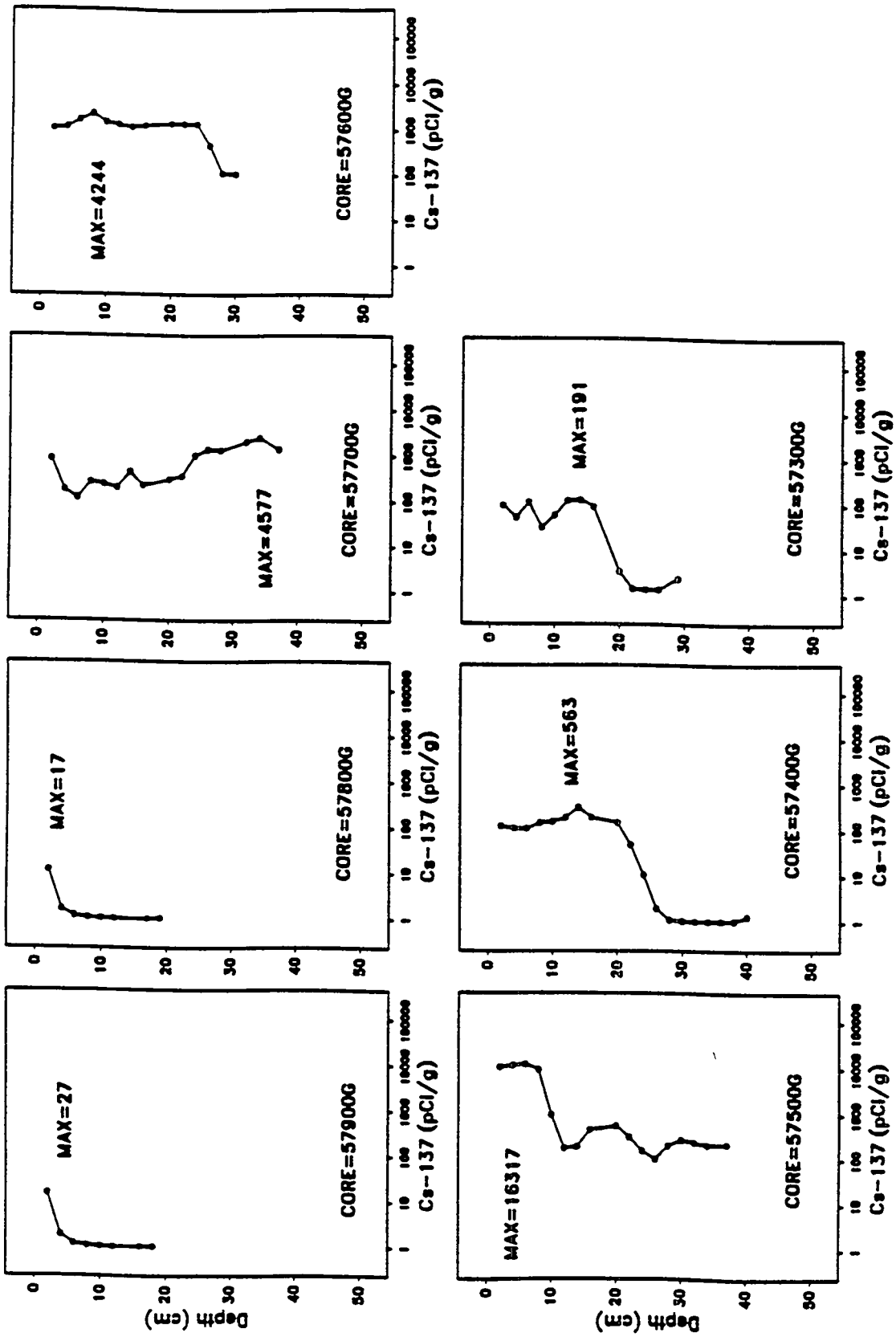

Fig. D2. Depth profiles for ^{137}Cs in sediment cores taken in transect across WOCE 10 m from the mouth (1 pCi = 0.037 Bq).

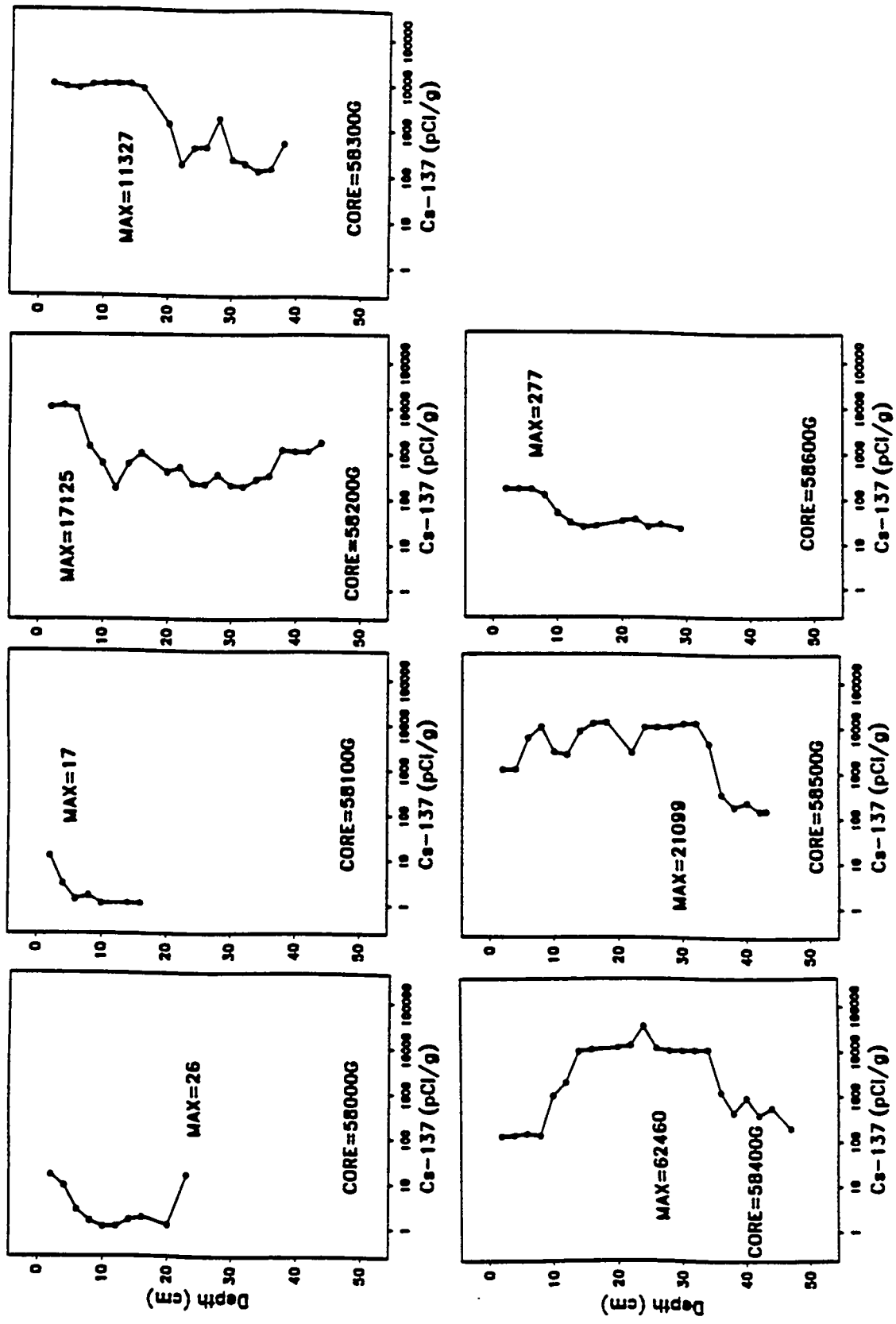

Fig. D3. Depth profiles for ^{137}Cs in sediment cores taken in transect across WOCE 20 m from the mouth (1 pCi = 0.037 Bq).

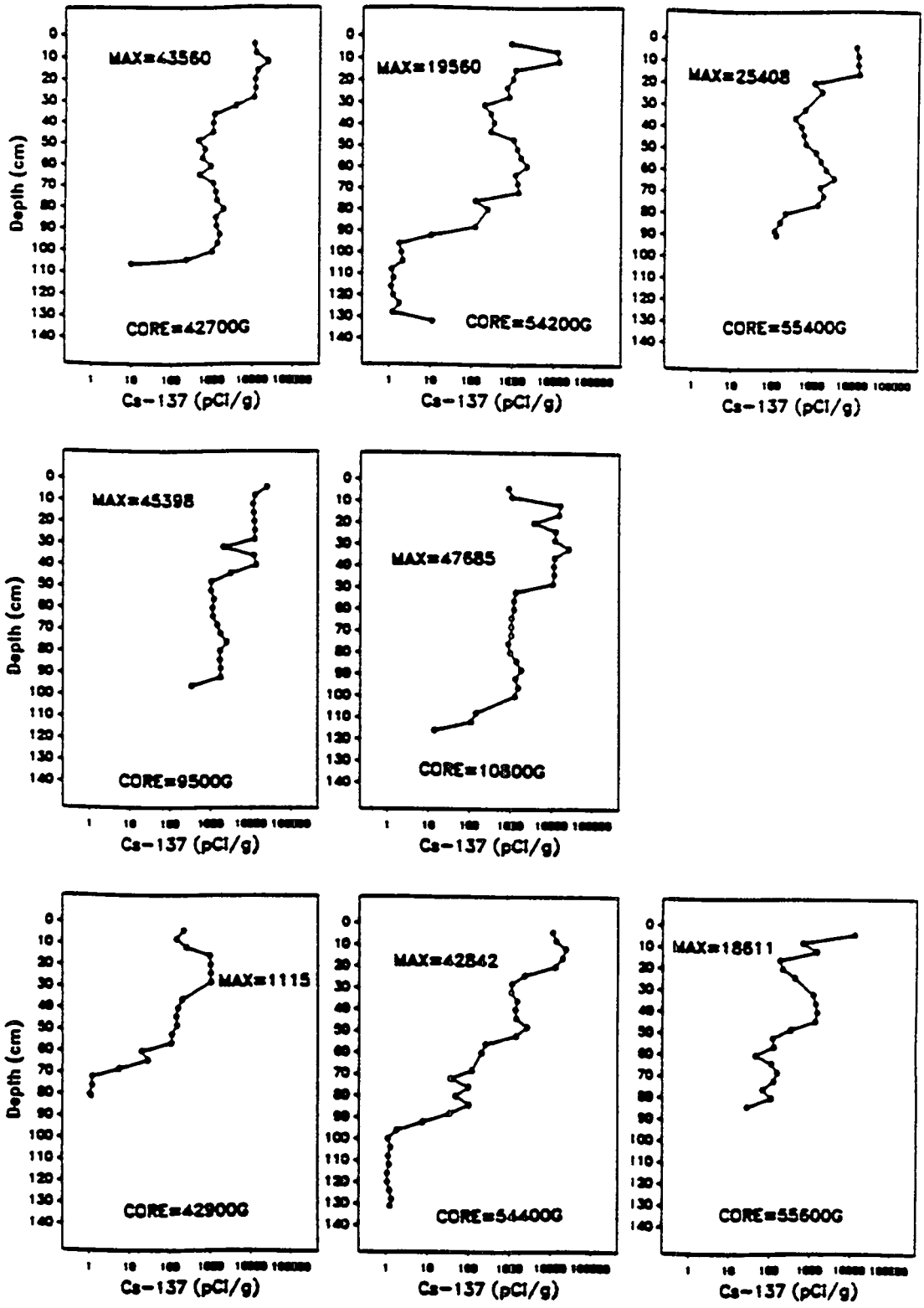

Fig. D4. Depth profiles for ^{137}Cs in sediment cores taken adjacent to each other at three locations in the embayment (Fig. 1.6).

Appendix E

SUMMARY OF NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) DATA COLLECTED AT WHITE OAK CREEK DAM FROM JANUARY 1989 TO SEPTEMBER 1990

Table E1. Summary of White Oak Creek Dam NPDES and radiological data collected from January 1989 - September 1990

Analysis Type	Compound	Number	Minimum Qualifier	Minimum Value	Maximum Qualifier	Maximum Value	Mean Value	Standard Deviation	Units
ANIONS	CL	91	<	0.010	<	0.010	0.010	0.000	MG/L
	F	21	<	1.000		1.000	1.000	0.000	MG/L
	NH4-N	21		0.011		0.160	0.061	0.045	MG/L
	NO3	21	<	5.000	<	5.000	5.000	0.000	MG/L
	P	24		0.100		1.000	0.306	0.179	MG/L
	SO4	21		12.000		48.000	34.857	9.598	MG/L
METALS	ALUMINUM	23	<	0.050		2.800	0.723	0.606	MG/L
	ARSENIC	23		0.002		0.090	0.049	0.016	MG/L
	CADMIUM	24	<	0.002	<	0.005	0.002	0.001	MG/L
	CHROMIUM	23	<	0.003		0.028	0.015	0.007	MG/L
	COPPER	23		0.005		0.130	0.013	0.026	MG/L
	IRON	23		0.075		2.300	0.640	0.449	MG/L
	LEAD	24	<	0.004	<	0.050	0.010	0.015	MG/L
	MANGANESE	25	<	0.002		0.160	0.077	0.033	MG/L
	MERCURY	23	<	0.000		0.000	0.000	0.000	MG/L
	NICKEL	23	<	0.004	<	0.020	0.008	0.005	MG/L
	SILVER	24	<	0.005	<	0.005	0.005	0.000	MG/L
	ZINC	23		0.008		0.040	0.020	0.010	MG/L
ORGANICS	CHLOROFORM	21	J	0.001	U	0.025	0.004	0.005	MG/L
	PCB	21	J	0.000	B	0.007	0.001	0.001	MG/L
	TRICHLOROETHYLENE	21	J	0.001	M	0.041	0.007	0.009	MG/L
RADIO-	AM-241	18		-0.008		0.058	0.015	0.015	BQ/L
NUCLIDES	CM-244	10		-0.061		0.064	0.018	0.032	BQ/L
	CO-60	82		-0.500		2.300	0.317	0.327	BQ/L
	CS-137	82		-0.400		12.000	2.151	2.075	BQ/L
	GROSS ALPHA	60		-1.389		1.215	0.265	0.426	BQ/L
	GROSS BETA	70		1.000		34.503	16.428	5.443	BQ/L
	OS-191	1		3.300		3.300	3.300	.	BQ/L
	PU-238	18		-0.002		0.019	0.003	0.005	BQ/L
	PU-239	18		-0.011		0.028	0.004	0.009	BQ/L
	TOTAL SR	32		3.800		14.000	6.759	2.281	BQ/L
	TRITIUM	32		2800.000		16000.000	10418.750	2929.102	BQ/L
WATER	BOD	21	<	5.000	>	34.000	6.381	6.328	MG/L
QUALITY	COND	21		0.230		1.900	1.078	0.587	MS/CM
	DO	91		14.600		4.000	8.660	2.363	MG/L
	O&G	91	<	2.000	>	200.000	10.651	29.924	MG/L
	PH	21		8.900		6.700	7.810	0.643	
	TDS	21		141.000		242.000	198.190	29.151	MG/L
	TEMP	112		3.900		29.400	17.512	6.634	DEG C
	TOC	21		1.700		6.800	3.124	1.431	MG/L
	TSS	21	<	5.000		37.000	12.952	9.405	MG/L
	TURB	21		10.000		319.000	87.538	80.760	NTU

< = less than detection limit.
J = value is estimated -- compound identified but value less than cotract required quantitation limit.
B = compound also detected in blank sample.

Appendix F

SUMMARY OF CONTAMINANT CONCENTRATIONS IN WHITE OAK CREEK EMBAYMENT WATER SAMPLES COLLECTED IN 1990

Table F1. Summary of inorganic, organic, and radioactive contaminant concentrations in WOCE water samples collected in 1990.

Analysis Type	Compound	Number	Min Qual[a]	Minimum Value	Max Qual	Maximum Value	Mean Value	Units
METALS	ANTIMONY	1	U	0.00190	U	0.00190	0.00190	MG/L
	ARSENIC	1	U	0.00130	U	0.00130	0.00130	MG/L
	BERYLLIUM	1	U	0.00390	U	0.00390	0.00390	MG/L
	CADMIUM	1	V/V	0.00240	V/V	0.00240	0.00240	MG/L
	CHROMIUM	1	U	0.00980	U	0.00980	0.00980	MG/L
	COPPER	1	U	0.00440	U	0.00440	0.00440	MG/L
	LEAD	1	U	0.00100	U	0.00100	0.00100	MG/L
	MERCURY	1	U	0.00020	U	0.00020	0.00020	MG/L
	NICKEL	1	U	0.01900	U	0.01900	0.01900	MG/L
	SELENIUM	1	U	0.00097	U	0.00097	0.00097	MG/L
	SILVER	1	U	0.00074	U	0.00074	0.00074	MG/L
	THALLIUM	1	U	0.00270	U	0.00270	0.00270	MG/L
	ZINC	1	V/V	0.02000	V/V	0.02000	0.02000	MG/L
	ANTIMONY	1	U	0.00190	U	0.00190	0.00190	MG/L
	ARSENIC	1	U	0.00130	U	0.00130	0.00130	MG/L
	BERYLLIUM	1	U	0.00390	U	0.00390	0.00390	MG/L
	CADMIUM	1	V/V	0.00036	V/V	0.00036	0.00036	MG/L
	CHROMIUM	1	V/V	0.01000	V/V	0.01000	0.01000	MG/L
	COPPER	1	U	0.00440	U	0.00440	0.00440	MG/L
	LEAD	1	U	0.00180	U	0.00180	0.00180	MG/L
	MERCURY	1	U	0.00020	U	0.00020	0.00020	MG/L
	NICKEL	1	U	0.01900	U	0.01900	0.01900	MG/L
	SELENIUM	1	U	0.00097	U	0.00097	0.00097	MG/L
	SILVER	1	U	0.00074	U	0.00074	0.00074	MG/L
	THALLIUM	1	U	0.00270	U	0.00270	0.00270	MG/L
	ZINC	1	V/V	0.01900	V/V	0.01900	0.01900	MG/L
ORGANICS	ACENAPHTHENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	ACENAPHTHYLENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	ALDRIN	1	U	0.00005	U	0.00005	0.00005	MG/L
	ALPHA-BHC	1	U	0.00005	U	0.00005	0.00005	MG/L
	ALPHA-CHLORDANE	1	U	0.00050	U	0.00050	0.00050	MG/L
	ANTHRACENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	AROCLOR-1016	1	U	0.00050	U	0.00050	0.00050	MG/L
	AROCLOR-1221	1	U	0.00050	U	0.00050	0.00050	MG/L
	AROCLOR-1232	1	U	0.00050	U	0.00050	0.00050	MG/L
	AROCLOR-1242	1	U	0.00050	U	0.00050	0.00050	MG/L
	AROCLOR-1248	1	U	0.00050	U	0.00050	0.00050	MG/L
	AROCLOR-1254	1	U	0.00100	U	0.00100	0.00100	MG/L
	AROCLOR-1260	1	U	0.00100	U	0.00100	0.00100	MG/L
	BENZO(A)ANTHRACENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	BENZO(A)PYRENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	BENZO(B)FLUORANTHENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	BENZO(G,H,I)PERYLENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	BENZO(K)FLUORANTHENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	BENZOIC ACID	1	U	0.05000	U	0.05000	0.05000	MG/L
	BENZYL ALCOHOL	1	U	0.01000	U	0.01000	0.01000	MG/L
	BETA-BHC	1	U	0.00005	U	0.00005	0.00005	MG/L
	BIS(2-CHLOROETHOXY)METHANE	1	U	0.01000	U	0.01000	0.01000	MG/L
	BIS(2-CHLOROETHYL)ETHER	1	U	0.01000	U	0.01000	0.01000	MG/L
	BIS(2-CHLOROISOPROPYL)ETHER	1	U	0.01000	U	0.01000	0.01000	MG/L
	BIS(2-ETHYLHEXYL)PHTHALATE	1	U	0.01000	U	0.01000	0.01000	MG/L
	BUTYLBENZYLPHTHALATE	1	U	0.01000	U	0.01000	0.01000	MG/L
	CHRYSENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	DELTA-BHC	1	U	0.00005	U	0.00005	0.00005	MG/L
	DI-N-BUTYLPHTHALATE	1	U	0.01000	U	0.01000	0.01000	MG/L
	DI-N-OCTYLPHTHALATE	1	U	0.01000	U	0.01000	0.01000	MG/L
	DIBENZ(A,H)ANTHRACENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	DIBENZOFURAN	1	U	0.01000	U	0.01000	0.01000	MG/L
	DIELDRIN	1	U	0.00010	U	0.00010	0.00010	MG/L
	DIETHYLPHTHALATE	1	U	0.01000	U	0.01000	0.01000	MG/L
	DIMETHYLPHTHALATE	1	U	0.01000	U	0.01000	0.01000	MG/L
	ENDOSULFAN I	1	U	0.00005	U	0.00005	0.00005	MG/L
	ENDOSULFAN II	1	U	0.00010	U	0.00010	0.00010	MG/L
	ENDOSULFAN SULFATE	1	U	0.00010	U	0.00010	0.00010	MG/L

Table F1 (continued)

Analysis Type	Compound	Number	Min Qual[a]	Minimum Value	Max Qual	Maximum Value	Mean Value	Units
ORGANICS	ENDRIN	1	U	0.00010	U	0.00010	0.00010	MG/L
	ENDRIN KETONE	1	U	0.00010	U	0.00010	0.00010	MG/L
	FLUORANTHENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	FLUORENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	GAMMA-BHC (LINDANE)	1	U	0.00005	U	0.00005	0.00005	MG/L
	GAMMA-CHLORDANE	1	U	0.00050	U	0.00050	0.00050	MG/L
	HEPTACHLOR	1	U	0.00005	U	0.00005	0.00005	MG/L
	HEPTACHLOR EPOXIDE	1	U	0.00005	U	0.00005	0.00005	MG/L
	HEXACHLOROBENZENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	HEXACHLOROBUTADIENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	HEXACHLOROCYCLOPENTADIENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	HEXACHLOROETHANE	1	U	0.01000	U	0.01000	0.01000	MG/L
	INDENO(1,2,3-CD)PYRENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	ISOPHORONE	1	U	0.01000	U	0.01000	0.01000	MG/L
	METHOXYCHLOR	1	U	0.00050	U	0.00050	0.00050	MG/L
	N-NITROSO-DI-N-PROPYLAMINE	1	U	0.01000	U	0.01000	0.01000	MG/L
	N-NITROSODIPHENYLAMINE	1	U	0.01000	U	0.01000	0.01000	MG/L
	NAPHTHALENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	NITROBENZENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	PENTACHLOROPHENOL	1	U	0.05000	U	0.05000	0.05000	MG/L
	PHENANTHRENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	PHENOL	1	U	0.01000	U	0.01000	0.01000	MG/L
	PYRENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	TOXAPHENE	1	U	0.00100	U	0.00100	0.00100	MG/L
	1,2-DICHLOROBENZENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	1,2,4-TRICHLOROBENZENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	1,3-DICHLOROBENZENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	1,4-DICHLOROBENZENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	2-CHLORONAPHTHALENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	2-CHLOROPHENOL	1	U	0.01000	U	0.01000	0.01000	MG/L
	2-METHYLNAPHTHALENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	2-METHYLPHENOL	1	U	0.01000	U	0.01000	0.01000	MG/L
	2-NITROANILINE	1	U	0.05000	U	0.05000	0.05000	MG/L
	2-NITROPHENOL	1	U	0.01000	U	0.01000	0.01000	MG/L
	2,4-DICHLOROPHENOL	1	U	0.01000	U	0.01000	0.01000	MG/L
	2,4-DIMETHYLPHENOL	1	U	0.01000	U	0.01000	0.01000	MG/L
	2,4-DINITROPHENOL	1	U	0.05000	U	0.05000	0.05000	MG/L
	2,4-DINITROTOLUENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	2,4,5-TRICHLOROPHENOL	1	U	0.05000	U	0.05000	0.05000	MG/L
	2,4,6-TRICHLOROPHENOL	1	U	0.01000	U	0.01000	0.01000	MG/L
	2,6-DINITROTOLUENE	1	U	0.01000	U	0.01000	0.01000	MG/L
	3-NITROANILINE	1	U	0.05000	U	0.05000	0.05000	MG/L
	3,3'-DICHLOROBENZIDINE	1	U	0.02000	U	0.02000	0.02000	MG/L
	4-BROMOPHENYL-PHENYLETHER	1	U	0.01000	U	0.01000	0.01000	MG/L
	4-CHLORO-3-METHYLPHENOL	1	U	0.01000	U	0.01000	0.01000	MG/L
	4-CHLOROANILINE	1	U	0.01000	U	0.01000	0.01000	MG/L
	4-CHLOROPHENYL-PHENYLETHER	1	U	0.01000	U	0.01000	0.01000	MG/L
	4-METHYLPHENOL	1	U	0.01000	U	0.01000	0.01000	MG/L
	4-NITROANILINE	1	U	0.05000	U	0.05000	0.05000	MG/L
	4-NITROPHENOL	1	U	0.05000	U	0.05000	0.05000	MG/L
	4,4'-DDD	1	U	0.00010	U	0.00010	0.00010	MG/L
	4,4'-DDE	1	U	0.00010	U	0.00010	0.00010	MG/L
	4,4'-DDT	1	U	0.00010	U	0.00010	0.00010	MG/L
	4,6-DINITRO-2-METHYLPHENOL	1	U	0.05000	U	0.05000	0.05000	MG/L
RAD	H-3	2	NOTV	10926.10	NOTV	11037.10	10981.60	BQ/L
	SR-90	3	NOTV	7.27420	J	8.09560	7.82180	BQ/L

[a]QUALIFIER CODES:

U = Compound was analyzed for but not detected.
J = Indicates an estimated value.
UJ = Compound was analyzed for but not detected and quantitation limit is an estimated value.
NJ = Tentative compound identification only and estimated concentration. No second column confirmation of pesticides.
V/V = Indicates that the result has been reviewed and is a valid result.
NOTV = Result not valid and for limited use in this report only. Value corroborated by ORNL radiological monitoring data but should be considered approximate.

Appendix G

SUMMARY OF CONTAMINANT CONCENTRATIONS IN WHITE OAK CREEK EMBAYMENT FISH COLLECTED IN 1990

Table G1. Summary of contaminant concentrations in WOCE fish samples collected in 1990

Analysis Type	Compound	Number	Min Qual*	Minimum Value	Max Qual	Maximum Value	Mean Value	Standard Deviation	Units
METALS	ANTIMONY	14	UJ	0.330	UJ	0.490	0.404	0.062	MG/KG
	ARSENIC	14	UJ	0.050	J	0.250	0.097	0.067	MG/KG
	BERYLLIUM	8	UJ	0.003	UJ	0.003	0.003	0.000	MG/KG
	CADMIUM	14	UJ	0.130	UJ	0.200	0.160	0.026	MG/KG
	CHROMIUM	14	UJ	0.330	UJ	0.490	0.404	0.062	MG/KG
	COPPER	14	UJ	0.330	J	1.000	0.484	0.192	MG/KG
	LEAD	14	UJ	0.330	UJ	0.490	0.404	0.062	MG/KG
	MERCURY	16	J	0.055	J	0.256	0.146	0.062	MG/KG
	NICKEL	14	UJ	0.330	UJ	0.490	0.404	0.062	MG/KG
	SELENIUM	14	UJ	0.380	J	1.100	0.631	0.204	MG/KG
	SILVER	14	UJ	0.130	UJ	0.200	0.160	0.026	MG/KG
	THALLIUM	14	UJ	0.020	UJ	0.020	0.020	0.000	MG/KG
	ZINC	14	J	4.600	J	12.000	6.921	1.926	MG/KG
ORGANICS	ACENAPHTHENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	ACENAPHTHYLENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	ALDRIN	8	UX	0.100	UX	0.100	0.100	0.000	MG/KG
	ALPHA-CHLORDANE	8	J	0.016	J	0.039	0.022	0.007	MG/KG
	ALPHA-CHLORDENE	8	J	0.001	UX	0.100	0.064	0.049	MG/KG
	ANTHRACENE	8	UJ	0.540	UJ	0.790	0.667	0.082	MG/KG
	AROCLOR-1254	8	NJ	0.040	NJ	1.210	0.554	0.378	MG/KG
	AROCLOR-1260	8	NJ	0.380	NJ	1.530	0.984	0.507	MG/KG
	BENZO(A)ANTHRACENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	BENZO(A)PYRENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	BENZO(B)FLUORANTHENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	BENZO(G,H,I)PERYLENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	BENZO(K)FLUORANTHENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	BENZOIC ACID	8	UX	2.700	UX	3.900	3.312	0.398	MG/KG
	BENZYL ALCOHOL	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	BIS(2-CHLOROETHOXY)METHANE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	BIS(2-CHLOROETHYL)ETHER	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	BIS(2-CHLOROISOPROPYL)ETHER	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	BIS(2-ETHYLHEXYL)PHTHALATE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	BUTYLBENZYLPHTHALATE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	CHLORDENE	8	J	0.001	UX	0.100	0.075	0.046	MG/KG
	CHRYSENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	DI-N-BUTYLPHTHALATE	8	UJ	0.540	UJ	0.790	0.667	0.082	MG/KG
	DI-N-OCTYLPHTHALATE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	DIBENZ(A,H)ANTHRACENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	DIBENZOFURAN	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	DIETHYLPHTHALATE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	DIMETHYLPHTHALATE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	FLUORANTHENE	8	UJ	0.540	UJ	0.790	0.667	0.082	MG/KG
	FLUORENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	GAMMA-CHLORDANE	8	J	0.008	J	0.027	0.013	0.006	MG/KG
	GAMMA-CHLORDENE	8	J	0.002	UX	0.100	0.054	0.049	MG/KG
	HEXACHLOROBENZENE	8	UJ	0.540	UJ	0.790	0.667	0.082	MG/KG
	HEXACHLOROBUTADIENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	HEXACHLOROCYCLOPENTADIENE	8	UX	0.540	UX	0.790	0.667	0.82	MG/KG
	HEXACHLOROETHANE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	INDENO(1,2,3-CD)PYRENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	ISOPHORONE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	N-NITROSO-DI-N-PROPYLAMINE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	N-NITROSODIPHENYLAMINE	8	UJ	0.540	UJ	0.790	0.667	0.082	MG/KG
	NAPHTHALENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	NITROBENZENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	OXYCHLORDANE	8	J	0.003	J	0.012	0.005	0.003	MG/KG
	PENTACHLOROPHENOL	8	UJ	2.700	UJ	3.900	3.312	0.398	MG/KG
	PHENANTHRENE	8	UJ	0.540	UJ	0.790	0.667	0.082	MG/KG
	PHENOL	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	PYRENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	1,2-DICHLOROBENZENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	1,2,4-TRICHLOROBENZENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	1,3-DICHLOROBENZENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	1,4-DICHLOROBENZENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	2-CHLORONAPHTHALENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	2-CHLOROPHENOL	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	2-METHYLNAPHTHALENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG

Table G1 (continued)

Analysis Type	Compound	Number	Min Qual	Minimum Value	Max Qual	Maximum Value	Mean Value	Standard Deviation	Units
ORGANICS	2-METHYLPHENOL	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	2-NITROANILINE	8	UX	2.700	UX	3.900	3.312	0.398	MG/KG
	2-NITROPHENOL	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	2,4-DICHLOROPHENOL	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	2,4-DIMETHYLPHENOL	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	2,4-DINITROPHENOL	8	UX	2.700	UX	3.900	3.312	0.398	MG/KG
	2,4-DINITROTOLUENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	2,4,5-TRICHLOROPHENOL	8	UX	2.700	UX	3.900	3.312	0.398	MG/KG
	2,4,6-TRICHLOROPHENOL	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	2,6-DINITROTOLUENE	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	3,3'-DICHLOROBENZIDINE	8	UX	1.100	UX	1.600	1.337	0.169	MG/KG
	4-BROMOPHENYL-PHENYLETHER	8	UJ	0.540	UJ	0.790	0.667	0.082	MG/KG
	4-CHLORO-3-METHYLPHENOL	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	4-CHLOROANILINE	8	UJ	0.540	UJ	0.790	0.667	0.082	MG/KG
	4-CHLOROPHENYL-PHENYLETHER	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	4-METHYLPHENOL	8	UX	0.540	UX	0.790	0.667	0.082	MG/KG
	4-NITROANILINE	8	UX	2.700	UX	3.900	3.312	0.398	MG/KG
	4-NITROPHENOL	8	UX	2.700	UX	3.900	3.312	0.398	MG/KG
	4,4'-DDD	8	J	0.008	UX	0.100	0.088	0.033	MG/KG
	4,4'-DDE	8	UX	0.100	UX	0.100	0.100	0.000	MG/KG
	4,4'-DDT	8	UX	0.100	UX	0.100	0.100	0.000	MG/KG
	4,6-DINITRO-2-METHYLPHENOL	8	UJ	2.700	UJ	3.900	3.312	0.398	MG/KG
RAD	CO-60	24	UJ	2.398	UJ	56.616	12.607	13.167	BQ/KG
	CS-137	24	UJ	4.849	V/V	647.574	152.114	139.909	BQ/KG
	U-235	14	U	8.773	U	458.534	63.687	117.350	BQ/KG

*QUALIFIER CODES:

U = Compound was analyzed for but not detected.
J = Indicates an estimated value.
UJ or UX = Compound was analyzed for but not detected and quantitation limit is an estimated value. See "X" description.
NJ = Tentative compound identification only and estimated concentration. No second column confirmation of pesticides.
X = Fish tissues were held frozen while awaiting extraction. Exceeded holding time for water samples but criteria are not applicable to biological samples. Results considered valid.
V/V = Indicates that the result has been verified and is a valid result.

Appendix H

CONSERVATIVE SCREENING OF THE DETECTABLE CONTAMINANTS DATA BASE FOR CARCINOGENS AND NONCARCINOGENS

Table H1. Results of conservative screening for carcinogens where at least one value was above detection limits

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	95% upper conf bound on mean (mg/kg)	Cancer slope factor 1/(mg/kg/d)	Daily intake (mg/kg/d)	Carcinogen screening index
Fish	Inorganic	Arsenic	7440-38-2	6/14	1.4E-01	1.75E+00	3.9E-05	7E-05
Fish	Inorganic	Total						7E-05
Fish	Organic	Aroclor-1254	11097-69-1	6/6	1.2E+00	7.70E+00	3.4E-04	3E-03
		Aroclor-1260	11096-82-5	6/6	9.8E-01	7.70E+00	2.8E-04	2E-03
		Chlordane	57-74-9	9/10	6.9E-02	1.30E+00	2.0E-05	3E-05
		4,4'-DDD	72-54-8	2/10	1.0E-01	2.40E-01	3.0E-05	7E-06
Fish	Organic	Total						5E-03
					(Bq/kg)	1/(Bq)	(Bq/lifetime)	
Fish	Radionuclide	Cs-137		21/24	2.1E+02	7.60E-10	1.1E+05	8E-05
		Sr-90		8/8	1.4E+01	8.90E-10	6.9E+03	6E-06
Fish	Radionuclide	Total						9E-05
Fish	All	Grand total						5E-03

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	95% upper conf bound on mean (Bq/kg)	Cancer slope factor 1/(yr/(Bq/m^2))	Carcinogen screening index
Sed ext exp	Radionuclide	Cs-137		101/101	2.8E+05	9.20E-10	2E-01
		Co-60		99/99	1.9E+03	3.50E-09	5E-03
		Eu-152		2/50	3.8E+02	1.70E-09	5E-04
		Eu-154		3/49	1.2E+02	1.80E-09	2E-04
		Am-241		3/3	1.2E+03	4.30E-11	4E-05
		Pu-239		3/3	9.0E+03	7.00E-13	4E-06
		U-235		3/3	2.0E+01	2.60E-10	4E-06
		Pu-238		3/3	1.1E+03	1.60E-12	1E-06
		U-234		3/3	4.2E+02	1.50E-12	4E-07
		U-238		3/3	2.5E+02	1.20E-12	2E-07
Sed ext exp	Radionuclide	External exposure total					2E-01

Table H1 (continued)

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	95% upper conf bound on mean (mg/kg)	Cancer slope factor 1/(mg/kg/d)	Daily intake (mg/kg/d)	Carcinogen screening index
Sediment	Inorganic	Arsenic	7440-38-2	7/7	9.9E+00	1.75E+00	1.4E-05	2E-05
		Beryllium	7440-41-7	3/3	3.2E+00	4.30E+00	4.6E-06	2E-05
		Uranium	7440-61-1	4/4	3.9E+00	5.60E-06	5.5E-06	3E-11
Sediment	Inorganic	Total						4E-05
Sediment	Organic	Aroclor-1254	11097-69-1	3/7	2.3E+00	7.70E+00	3.2E-06	2E-05
		Aroclor-1260	11096-82-5	1/7	2.1E+00	7.70E+00	3.0E-06	2E-05
		Bis(2-ethylhexyl)phthalate	117-81-7	5/7	9.7E-01	1.40E-02	1.4E-06	2E-08
Sediment	Organic	Total						5E-05
					(Bq/kg)	1/(Bq)	(Bq/lifetime)	
Sediment	Radionuclide	Cs-137		101/101	2.8E+05	7.60E-10	3.0E+05	2E-04
		Sr-90		3/3	5.6E+04	8.90E-10	5.9E+04	5E-05
		Am-241		3/3	1.2E+03	8.40E-09	1.2E+03	1E-05
		Pu-238		3/3	1.1E+03	6.00E-10	1.1E+03	9E-06
		Pu-239		3/3	9.0E+03	8.40E-10	9.4E+03	8E-06
		U-234		3/3	4.2E+02	3.80E-09	4.4E+02	2E-06
		U-238		3/3	2.5E+02	3.50E-09	2.6E+02	9E-07
		Co-60		99/99	1.9E+03	4.10E-10	2.0E+03	8E-07
		U-235		3/3	2.0E+01	3.50E-09	2.1E+01	7E-08
		Eu-152		2/50	3.8E+02	5.70E-11	4.0E+02	2E-08
		Eu-154		3/49	1.2E+02	8.10E-11	1.2E+02	1E-08
Sediment	Radionuclide	Total						3E-04
Sediment	All	Ingestion grand total						4E-04

Table H1 (continued)

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	95% upper conf bound on mean (mg/L)	Cancer slope factor 1/(mg/kg/d)	Daily intake (mg/kg/d)	Carcinogen screening index
Water	Inorganic	Arsenic	7440-38-2	2/24	5.5E-02	1.75E+00	1.6E-03	3E-03
Water	Inorganic	Total						3E-03
Water	Organic	PCBs total	1336-36-3	2/21	1.8E-03	7.70E+00	5.0E-05	4E-04
		Trichloroethylene	79-01-6	1/20	7.9E-03	1.10E-02	2.3E-04	2E-06
		Chloroform	67-66-3	11/21	6.5E-03	6.10E-03	1.8E-04	1E-06
Water	Organic	Total						4E-04
					(Bq/L)	1/(Bq)	(Bq/lifetime)	
Water	Radionuclide	H-3		32/32	1.1E+04	1.50E-12	5.9E+08	9E-04
		Sr-90		32/32	7.6E+00	8.90E-10	3.9E+05	3E-04
		Cs-137		82/82	2.6E+00	7.60E-10	1.3E+05	1E-04
		Cm-244		10/10	3.7E-02	5.40E-09	1.9E+03	1E-05
		Am-241		18/18	2.2E-02	8.40E-09	1.1E+03	1E-05
		Co-60		82/82	4.0E-01	4.10E-10	2.0E+04	8E-06
		Pu-238		18/18	5.3E-03	7.60E-09	2.7E+02	2E-06
		Pu-239		18/18	9.0E-03	8.40E-10	4.6E+02	4E-07
Water	Radionuclide	Total						1E-03
Water	All	Grand total						4E-03

Table H2. Results of conservative screening for noncarcinogens where at least one value was above detection limits

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	95% upper conf bound on mean (mg/kg)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening index
Fish	Inorganic	Mercury	7439-97-6	16/16	1.8E-01	3.0E-04	5.1E-05	2E-01
		Selenium	7782-49-2	12/14	7.5E-01	5.0E-03	2.1E-04	4E-02
		Arsenic	7440-38-2	6/14	1.4E-01	1.0E-03	3.9E-05	4E-02
		Zinc	7440-66-6	14/14	8.0E+00	2.0E-01	2.3E-03	1E-02
	Inorganic	Total						3E-01
Fish	Organic	Chlordane	57-74-9	9/10	6.9E-02	6.0E-05	2.0E-05	3E-01
Fish	Organic	Total						3E-01
Fish	**All**	**Grand total**						**6E-01**

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	95% upper conf bound on mean (mg/kg)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening index
Sediment	Inorganic	Mercury	7439-97-6	7/7	1.1E+02	3.0E-04	1.5E-04	5E-01
		Chromium	7440-47-3	7/7	2.1E+02	5.0E-03	3.0E-04	6E-02
		Arsenic	7440-38-2	7/7	9.9E+00	1.0E-03	1.4E-05	1E-02
		Silver	7440-22-4	7/7	1.6E+01	3.0E-03	2.3E-05	8E-03
		Cadmium	7440-43-9	7/7	3.5E+00	1.0E-03	5.0E-06	5E-03
		Nickel	7440-02-0	7/7	2.7E+01	2.0E-02	3.9E-05	2E-03
		Uranium	7440-61-1	4/4	3.9E+00	3.0E-03	5.5E-06	2E-03
		Zinc	7440-66-6	3/3	1.4E+02	2.0E-01	2.0E-04	1E-03
		Beryllium	7440-41-7	3/3	3.2E+00	5.0E-03	4.6E-06	9E-04
Sediment	Inorganic	Total						6E-01
Sediment	Organic	Bis(2-ethylhexyl)phthalate	117-81-7	5/7	9.7E-01	2.0E-02	1.4E-06	7E-05
		Diethylphthalate	84-66-2	1/7	3.3E+00	8.0E-01	4.7E-06	6E-06
Sediment	Organic	Total						8E-05
Sediment	**All**	**Grand total**						**6E-01**

Table H2 (continued)

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	95% upper conf bound on mean (mg/L)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening index
Water	Inorganic	Arsenic	7440-38-2	2/24	5.5E-02	1.0E-03	1.6E-03	2E+00
		Chromium	7440-47-3	20/24	1.7E-02	5.0E-03	4.9E-04	1E-01
		Cadmium	7440-43-9	1/25	2.7E-03	1.0E-03	7.8E-05	8E-02
		Nickel	7440-02-0	2/24	1.1E-02	2.0E-02	3.1E-04	2E-02
		Mercury	7439-97-6	7/24	7.8E-05	3.0E-04	2.2E-06	7E-03
		Zinc	7440-66-6	22/24	2.5E-02	2.0E-01	7.1E-04	4E-03
Water	Inorganic	Total						2E+00
Water	Organic	Chloroform	67-66-3	11/21	6.5E-03	1.0E-02	1.8E-04	2E-02
Water	Organic	Total						2E-02
Water	All	Grand total						2E+00

Appendix I

NONCONSERVATIVE SCREENING OF THE DETECTABLE CONTAMINANTS DATA BASE FOR CARCINOGENS AND NONCARCINOGENS

Table I1. Results of nonconservative screening for carcinogens where at least one value was above detection limits

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	Geom. mean (mg/kg)	Cancer slope factor 1/(mg/kg/d)	Daily intake (mg/kg/d)	Carcinogen screening index
Fish	Inorganic	Arsenic	7440-38-2	6/14	8.0E-02	1.75E+00	2.3E-06	4E-06
Fish	Inorganic	Total						4E-06
Fish	Organic	Aroclor-1254	11097-69-1	6/6	5.0E-01	7.70E+00	1.4E-05	1E-04
		Aroclor-1260	11096-82-5	6/6	3.3E-01	7.70E+00	9.5E-06	7E-05
		Chlordane	57-74-9	9/10	3.9E-02	1.30E+00	1.1E-06	1E-06
		4,4'-DDD	72-54-8	2/10	5.0E-02	2.40E-01	1.4E-06	3E-07
Fish	Organic	Total						2E-04
					(Bq/kg)	1/(Bq)	(Bq/lifetime)	
Fish	Radionuclide	Cs-137		21/24	9.3E+01	7.60E-10	4.8E+03	4E-06
		Sr-90		8/8	5.4E+00	8.90E-10	2.8E+02	2E-07
Fish	Radionuclide	Total						4E-06
Fish	All	Grand total						2E-04

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	Geom. mean (Bq/kg)	Cancer slope factor 1/(yr/(Bq/m^2))	Carcinogen screening index
Sed ext exp	Radionuclide	Cs-137		101/101	4.6E+04	9.20E-10	3E-03
		Co-60		99/99	6.9E+02	3.50E-09	2E-04
		Eu-152		2/50	2.0E+02	1.70E-09	2E-05
		Eu-154		3/49	6.6E+01	1.80E-09	8E-06
		Am-241		3/3	7.4E+02	4.30E-11	2E-06
		Pu-239		3/3	7.0E+03	7.00E-13	3E-07
		U-235		3/3	1.6E+01	2.60E-10	3E-07
		U-234		3/3	3.8E+02	1.50E-12	4E-08
		U-238		3/3	2.4E+02	1.20E-12	2E-08
		Pu-238		3/3	1.7E+02	1.60E-12	2E-08
Sed ext exp	Radionuclide	External exposure total					3E-03

Table I1 (continued)

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	Geom. mean (mg/L)	Cancer slope factor 1/(mg/kg/d)	Daily intake (mg/kg/d)	Carcinogen screening index
Water	Inorganic	Arsenic	7440-38-2	2/24	3.7E-02	1.75E+00	1.0E-04	2E-04
Water	Inorganic	Total						2E-04
Water	Organic	PCBs Total	1336-36-3	2/21	7.4E-04	7.70E+00	2.1E-06	2E-05
		Trichloroethylene	79-01-6	1/20	4.9E-03	1.10E-02	1.4E-05	2E-07
		Chloroform	67-66-3	11/21	2.8E-03	6.10E-03	8.1E-06	5E-08
Water	Organic	Total						2E-05
					(Bq/L)	1/(Bq)	(Bq/lifetime)	
Water	Radionuclide	H-3		32/32	9.9E+03	1.50E-12	5.1E+07	8E-05
		Sr-90		32/32	6.4E+00	8.90E-10	3.3E+04	3E-05
		Cs-137		82/82	1.4E+00	7.60E-10	7.0E+03	5E-06
		Am-241		18/18	8.2E-03	8.40E-09	4.2E+01	4E-07
		Co-60		82/82	1.6E-01	4.10E-10	8.2E+02	3E-07
		Cm-244		10/10	1.0E-02	5.40E-09	5.3E+01	3E-07
		Pu-238		18/18	9.5E-04	7.60E-09	4.8E+00	4E-08
		Pu-239		18/18	1.5E-03	8.40E-10	7.4E+00	6E-09
Water	Radionuclide	Total						1E-04
Water	All	Grand total						3E-04

Table I1 (continued)

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	Geom. mean (mg/kg)	Cancer slope factor 1/(mg/kg/d)	Daily intake (mg/kg/d)	Carcinogen screening index
Sediment	Inorganic	Beryllium	7440-41-7	3/3	2.7E+00	4.30E+00	3.8E-07	2E-06
		Arsenic	7440-38-2	7/7	6.0E+00	1.75E+00	8.6E-07	1E-06
		Uranium	7440-61-1	4/4	1.3E+00	5.60E-06	1.9E-07	1E-12
Sediment	Inorganic	Total						3E-06
Sediment	Organic	Aroclor-1260	11096-82-5	1/7	4.2E-01	7.70E+00	6.0E-08	5E-07
		Aroclor-1254	11097-69-1	3/7	3.1E-01	7.70E+00	4.5E-08	3E-07
		Bis(2-ethylhexyl)phthalate	117-81-7	5/7	6.8E-01	1.40E-02	9.6E-08	1E-09
Sediment	Organic	Total						8E-07
					(Bq/kg)	1/(Bq)	(Bq/lifetime)	
Sediment	Radionuclide	Cs-137		101/101	4.6E+04	7.60E-10	4.9E+03	4E-06
		Sr-90		3/3	3.4E+04	8.90E-10	3.6E+03	3E-06
		Am-241		3/3	7.4E+02	8.40E-09	7.8E+01	7E-07
		Pu-239		3/3	7.0E+03	8.40E-10	7.4E+02	6E-07
		U-234		3/3	3.8E+02	3.80E-09	4.0E+01	2E-07
		Pu-238		3/3	1.7E+02	7.60E-09	1.8E+01	1E-07
		U-238		3/3	2.4E+02	3.50E-09	2.5E+01	9E-08
		Co-60		99/99	6.9E+02	4.10E-10	7.2E+01	3E-08
		U-235		3/3	1.6E+01	3.50E-09	1.7E+00	6E-09
		Eu-152		2/50	2.0E+02	5.70E-11	2.1E+01	1E-09
		Eu-154		3/49	6.6E+01	8.10E-11	6.9E+00	6E-10
Sediment	Radionuclide	Total						9E-06
Sediment	All	Ingestion grand total						1E-05

Table I2. Results of nonconservative screening for noncarcinogens where at least one value was above detection limits

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	Geom. mean (mg/kg)	RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening index
Fish	Inorganic	Mercury	7439-97-6	16/16	1.3E-01	3.0E-04	3.8E-06	1E-02
		Selenium	7782-49-2	12/14	6.0E-01	5.0E-03	1.7E-05	3E-03
		Arsenic	7440-38-2	6/14	8.0E-02	1.0E-03	2.3E-06	2E-03
		Zinc	7440-66-6	14/14	6.7E+00	2.0E-01	1.9E-04	1E-03
Fish	**Inorganic**	**Total**						**2E-02**
Fish	Organic	Chlordane	57-74-9	9/10	3.9E-02	6.0E-05	1.1E-06	2E-02
Fish	**Organic**	**Total**						**2E-02**
Fish	**All**	**Grand total**						**4E-02**

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	Geom. mean (mg/kg)	RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening index
Sediment	Inorganic	Mercury	7439-97-6	7/7	1.4E+01	3.0E-04	2.0E-06	7E-03
		Chromium	7440-47-3	7/7	1.2E+02	5.0E-03	1.7E-05	3E-03
		Arsenic	7440-38-2	7/7	6.0E+00	1.0E-03	8.6E-07	9E-04
		Silver	7440-22-4	7/7	8.1E+00	3.0E-03	1.2E-06	4E-04
		Cadmium	7440-43-9	7/7	2.0E+00	1.0E-03	2.8E-07	3E-04
		Nickel	7440-02-0	7/7	2.5E+01	2.0E-02	3.6E-06	2E-04
		Zinc	7440-66-6	3/3	1.1E+02	2.0E-01	1.6E-05	8E-05
		Beryllium	7440-41-7	3/3	2.7E+00	5.0E-03	3.8E-07	8E-05
		Uranium	7440-61-1	4/4	1.3E+00	3.0E-03	1.9E-07	6E-05
Sediment	**Inorganic**	**Total**						**1E-02**
Sediment	Organic	Bis(2-ethylhexyl)phthalate	117-81-7	5/7	6.8E-01	2.0E-02	9.6E-08	5E-06
		Diethylphthalate	84-66-2	1/7	9.1E-01	8.0E-01	1.3E-07	2E-07
Sediment	**Organic**	**Total**						**5E-06**
Sediment	**All**	**Grand total**						**1E-02**

Table I2 (continued)

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	Geom. mean (mg/L)	RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening index
Water	Inorganic	Arsenic	7440-38-2	2/24	3.7E-02	1.0E-03	1.0E-04	1E-01
		Chromium	7440-47-3	20/24	1.3E-02	5.0E-03	3.6E-05	7E-03
		Cadmium	7440-43-9	1/25	2.1E-03	1.0E-03	6.0E-06	6E-03
		Nickel	7440-02-0	2/24	7.3E-03	2.0E-02	2.1E-05	1E-03
		Mercury	7439-97-6	7/24	5.9E-05	3.0E-04	1.7E-07	6E-04
		Zinc	7440-66-6	22/24	1.8E-02	2.0E-01	5.1E-05	3E-04
Water	**Inorganic**	**Total**						**1E-01**
Water	Organic	Chloroform	67-66-3	11/21	2.8E-03	1.0E-02	8.1E-06	8E-04
Water	**Organic**	**Total**						**8E-04**
Water	**All**	**Grand total**						**1E-01**

Appendix J

SCREENING OF THE INTRUDER SCENARIO FOR DETECTED CARCINOGENS AND NONCARCINOGENS

Table J1. Intermittent intruder scenario screening indices for detected carcinogens

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	Geom mean (mg/kg)	Cancer slope factor 1/(mg/kg/d)	Daily intake (mg/kg/d)	Carcinogen screening index
Fish	Inorganic	Arsenic	7440-38-2	6/14	8.0E-02	1.75E+00	1.8E-04	5E-06
Fish	Inorganic	Total						5E-06
Fish	Organic	Aroclor-1254	11097-69-1	6/6	5.0E-01	7.70E+00	1.2E-03	1E-04
		Aroclor-1260	11096-82-5	6/6	3.3E-01	7.70E+00	7.7E-04	8E-05
		Chlordane	57-74-9	9/10	3.9E-02	1.30E+00	9.0E-05	2E-06
		4,4'-DDD	72-54-8	2/10	5.0E-02	2.40E-01	1.2E-04	4E-07
Fish	Organic	Total						2E-04
					(Bq/kg)	1/(Bq)	(Bq/10 y)	
Fish	Radionuclide	Cs-137		21/24	9.3E+01	7.60E-10	5.6E+03	4E-06
		Sr-90		8/8	5.4E+00	8.90E-10	3.3E+02	3E-07
Fish	Radionuclide	Ingestion total						5E-06
Fish	All	Ingestion grand total						2E-04
					(Bq/kg)	1/(yr/(Bq/m^2))		
Sed ext exp	Radionuclide	Cs-137		101/101	4.6E+04	9.20E-10		5E-04
		Co-60		99/99	6.9E+02	3.50E-09		3E-05
		Eu-152		2/50	2.0E+02	1.70E-09		4E-06
		Eu-154		3/49	6.6E+01	1.80E-09		1E-06
		Am-241		3/3	7.4E+02	4.30E-11		3E-07
		Pu-239		3/3	7.0E+03	7.00E-13		5E-08
		U-235		3/3	1.6E+01	2.60E-10		5E-08
		U-234		3/3	3.8E+02	1.50E-12		6E-09
		U-238		3/3	2.4E+02	1.20E-12		3E-09
		Pu-238		3/3	1.7E+02	1.60E-12		3E-09
Sed ext exp	Radionuclide	External exposure total						5E-04
All	All	Grand total						7E-04

Table J2. Intermittent intruder scenario screening indices for detected noncarcinogens

Media	Contaminant type	Contaminant	CAS no.	Ratio of detected to total no. of samples	Geom mean (mg/kg)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening index
Fish	Inorganic	Arsenic	7440-38-2	6/14	8.0E-02	1.0E-03	1.3E-03	2E-02
		Mercury	7439-97-6	16/16	1.3E-01	3.0E-04	2.2E-03	1E-01
		Selenium	7782-49-2	12/14	6.0E-01	5.0E-03	9.9E-03	3E-02
		Zinc	7440-66-6	14/14	6.7E+00	2.0E-02	1.1E-01	8E-03
Fish	Inorganic	Total						2E-01
Fish	Organic	Chlordane	57-74-9	9/10	3.9E-02	6.0E-05	6.4E-04	2E-01
Fish	Organic	Total						2E-01
Fish	**All**	**Grand total**						**3E-01**

Appendix K

CONSERVATIVE SCREENING OF THE NONDETECTABLE CONTAMINANTS DATA BASE FOR CARCINOGENS AND NONCARCINOGENS

Table K1. Results of conservative screening for carcinogens where no samples were above detection limits (Concentrations are the 95% upper confidence bound of the arithmetic mean of the detection limits)

Contaminant type	Contaminant	No. fish samples	Fish conc (mg/kg)	Carcinogen screen index fish ingest	No. sed samples	Sediment conc (mg/kg)	Carcinogen screen index sed ingest	No. water samples	Water conc (mg/L)	Carcinogen screen index water ingest
Inorganic	Beryllium	14	3.0E-03	4E-06				1	3.9E-03	5E-04
Organic	Acenaphthene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Acenaphthylene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Anthracene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Benzo(a)pyrene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Benzo(b)fluoranthene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Benzo(g,h,i)perylene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Benzo(k)fluoranthene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Chrysene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Dibenz(a,h)anthracene	8	7.4E-01	2E-03	7	8.9E+00	5E-05	1	1.0E-02	3E-03
	Fluoranthene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Fluorene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Indeno(1,2,3-cd)pyrene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Pyrene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Benzo(a)anthracene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Phenanthrene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	N-nitroso-di-n-propylamine	8	7.4E-01	1E-03	7	3.3E+00	3E-05		1.0E-02	
	Benzidine				4	4.5E+00	1E-03			
	Hexachlorobenzene	8	7.4E-01	4E-04	7	5.9E+00	1E-05	1	1.0E-02	5E-04
	Aldrin	10	1.1E-01	5E-04	3	2.5E-01	6E-06	1	5.0E-05	2E-05
	Bis(2-chloroethyl)ether	8	7.4E-01	2E-04	7	3.3E+00	5E-06	1	1.0E-02	3E-04
	3,3'-Dichlorobenzidine	8	1.5E+00	2E-04	7	6.6E+00	4E-06	1	2.0E-02	3E-04
	2,4-Dinitrotoluene	8	7.4E-01	1E-04	7	3.3E+00	3E-06	1	1.0E-02	2E-04
	2,6-Dinitrotoluene	8	7.4E-01	1E-04	7	3.3E+00	3E-06	1	1.0E-02	2E-04
	Pentachlorophenol	8	3.6E+00	1E-04	3	4.3E+01	7E-06	1	5.0E-02	2E-04
	Aroclor-1254							1	1.0E-03	2E-04
	Aroclor-1260							1	1.0E-03	2E-04
	N-nitrosodimethylamine				4	9.1E-01	7E-05			
	Dieldrin				3	5.1E-01	1E-05	1	1.0E-04	5E-05
	Toxaphene				3	5.1E+00	8E-06	1	1.0E-03	3E-05
	Hexachlorobutadiene	8	7.4E-01	2E-05	7	3.3E+00	4E-07	1	1.0E-02	2E-05
	Chlordane				3	2.5E+00	5E-06	1	5.0E-04	2E-05
	Heptachlor epoxide				3	2.5E-01	3E-06	1	5.0E-05	1E-05
	1,4-Dichlorobenzene	8	7.4E-01	5E-06	7	3.3E+00	1E-07	1	1.0E-02	7E-06

Table K1 (continued)

Contaminant type	Contaminant	No. fish samples	Fish conc (mg/kg)	Carcinogen screen index fish ingest	No. sed samples	Sediment conc (mg/kg)	Carcinogen screen index sed ingest	No. water samples	Water conc (mg/L)	Carcinogen screen index water ingest
Organic	4,4'-DDE	10	1.1E-01	1E-05	3	5.1E-01	2E-07	1	1.0E-04	1E-06
	4,4'-DDT	10	1.1E-01	1E-05	3	5.1E-01	2E-07	1	1.0E-04	1E-06
	Alpha-BHC				3	2.5E-01	2E-06	1	5.0E-05	9E-06
	Heptachlor				3	2.5E-01	2E-06	1	5.0E-05	6E-06
	Hexachloroethane	8	7.4E-01	3E-06	7	3.3E+00	7E-08	1	1.0E-02	4E-06
	2,4,6-Trichlorophenol	8	7.4E-01	2E-06	3	8.9E+00	1E-07	1	1.0E-02	3E-06
	Beta-BHC				3	2.5E-01	6E-07	1	5.0E-05	3E-06
	Bis(2-ethylhexyl)phthalate	8	7.4E-01	3E-06					1.0E-02	
	N-Nitrosodiphenylamine	8	7.4E-01	1E-06	7	5.9E+00	4E-08	1	1.0E-02	1E-06
	Gamma-BHC (Lindane)				3	2.5E-01	5E-07	1	5.0E-05	2E-06
	Isophorone	8	7.4E-01	9E-07	7	3.3E+00	2E-08	1	1.0E-02	1E-06
	1,2-Diphenylhydrazine				4	9.1E-01	1E-06			
	4,4'-DDD				3	5.1E-01	2E-07	1	1.0E-04	7E-07

Contaminant type	Contaminant	No. fish samples	Fish conc (mg/kg)	Carcinogen screen index fish ingest	No. sed samples	Sediment conc (mg/kg)	Carcinogen screen index sed ingest	No. water samples	Water conc (mg/L)	Carcinogen screen index water ingest	Carcinogen screening index sed ext exposure
Radionuclide	U-235	8		4E-05							
	Co-60	8		1E-06							

Table K2. Results of conservative screening for noncarcinogens where no samples were above detection limits (Concentrations are the 95% upper confidence bound of the arithmetic mean of the detection limits)

Contaminant type	Contaminant	No. fish samples	Fish conc (mg/kg)	Noncarcin screen index fish ingest	No. sed samples	Sediment conc (mg/kg)	Noncarcin screen index sed ingest	No. water samples	Water conc (mg/L)	Noncarcin screen index water ingest
Inorganic	Thallium	14	2.0E-02	8E-02	3	7.2E-01	1E-02	1	2.7E-03	1E+00
	Antimony	14	4.4E-01	3E-01	3	1.0E+01	4E-02	1	1.9E-03	1E-01
	Silver	14	1.8E-01	2E-02				25	5.2E-03	5E-02
	Cadmium	14	1.8E-01	5E-02						
	Chromium	14	4.4E-01	3E-02						
	Beryllium	14	3.0E-03	2E-04				1	3.9E-03	2E-02
	Nickel	14	4.4E-01	6E-03						
	Selenium				3	1.0E-05	3E-09	1	9.7E-04	6E-03
	Cyanide				4	1.0E+00	7E-05			
Organic	4,6-Dinitro-2-methylphenol	8	3.6E+00	1E+01	3	4.3E+01	6E-01		5.0E-02	
	2,4-Dinitrophenol	8	3.6E+00	5E-01	3	4.3E+01	3E-02	1	5.0E-02	7E-01
	Aldrin	10	1.1E-01	1E+00	3	2.5E-01	1E-02	1	5.0E-05	5E-02
	Nitrobenzene	8	7.4E-01	4E-01	7	3.3E+00	9E-03	1	1.0E-02	6E-01
	Hexachlorobenzene	8	7.4E-01	3E-01	7	5.9E+00	1E-02	1	1.0E-02	4E-01
	Hexachloroethane	8	7.4E-01	2E-01	7	3.3E+00	5E-03	1	1.0E-02	3E-01
	1,2,4-Trichlorobenzene	8	7.4E-01	2E-01	7	3.3E+00	4E-03	1	1.0E-02	2E-01
	Chlordane				3	2.5E+00	6E-02	1	5.0E-04	2E-01
	Hexachlorobutadiene	8	7.4E-01	1E-01	7	3.3E+00	2E-03	1	1.0E-02	1E-01
	2,4-Dichlorophenol	8	7.4E-01	7E-02	3	8.9E+00	4E-03	1	1.0E-02	1E-01
	Heptachlor epoxide				3	2.5E-01	3E-02	1	5.0E-05	1E-01
	4-Chloroaniline	8	7.4E-01	5E-02	3	8.9E+00	3E-03	1	1.0E-02	7E-02
	Naphthalene	8	7.4E-01	5E-02	7	3.3E+00	1E-03	1	1.0E-02	7E-02
	2-Chlorophenol	8	7.4E-01	4E-02	3	8.9E+00	3E-03	1	1.0E-02	6E-02
	Pentachlorophenol	8	3.6E+00	3E-02	3	4.3E+01	2E-03	1	5.0E-02	5E-02
	Dieldrin				3	5.1E-01	1E-02	1	1.0E-04	6E-02
	Endosulfan II				3	5.1E-01	1E-02	1	1.0E-04	6E-02
	Hexachlorocyclopentadiene	8	7.4E-01	3E-02	7	3.3E+00	7E-04	1	1.0E-02	4E-02
	4,4'-DDT	10	1.1E-01	6E-02	3	5.1E-01	1E-03	1	1.0E-04	6E-03
	Dibenzofuran	8	7.4E-01	2E-02	3	8.9E+00	1E-03	1	1.0E-02	3E-02
	Endosulfan I				3	2.5E-01	7E-03	1	5.0E-05	3E-02
	2,4-Dimethylphenol	8	7.4E-01	1E-02	3	8.9E+00	6E-04	1	1.0E-02	1E-02
	2,4,5-Trichlorophenol	8	3.6E+00	1E-02	3	4.3E+01	6E-04	1	5.0E-02	1E-02
	Pyrene	8	7.4E-01	7E-03	7	3.3E+00	2E-04	1	1.0E-02	1E-02
	Fluoranthene	8	7.4E-01	5E-03	7	3.3E+00	1E-04	1	1.0E-02	7E-03

Table K2 (continued)

Contaminant type	Contaminant	No. fish samples	Fish conc (mg/kg)	Noncarcin screen index fish ingest	No. sed samples	Sediment conc (mg/kg)	Noncarcin screen index sed ingest	No. water samples	Water conc (mg/L)	Noncarcin screen index water ingest
Organic	Fluorene	8	7.4E-01	5E-03	7	3.3E+00	1E-04	1	1.0E-02	7E-03
	Endrin				3	5.1E-01	2E-03	1	1.0E-04	1E-02
	Bis(2-ethylhexyl)phthalate	8	7.4E-01	1E-02					1.0E-02	
	2-Methylphenol	8	7.4E-01	4E-03	3	8.9E+00	3E-04	1	1.0E-02	6E-03
	4-Methylphenol	8	7.4E-01	4E-03	3	8.9E+00	3E-04	1	1.0E-02	6E-03
	Acenaphthene	8	7.4E-01	4E-03	7	3.3E+00	8E-05	1	1.0E-02	5E-03
	Gamma-BHC (Lindane)				3	2.5E-01	1E-03	1	5.0E-05	5E-03
	1,2-Dichlorobenzene	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Bis(2-chloroisopropyl)ether	8	7.4E-01	5E-03	7	3.3E+00	1E-04		1.0E-02	
	Di-n-butylphthalate	8	7.4E-01	2E-03	7	3.3E+00	5E-05	1	1.0E-02	3E-03
	Methoxychlor				3	2.5E+00	7E-04	1	5.0E-04	3E-03
	Heptachlor				3	2.5E-01	7E-04	1	5.0E-05	3E-03
	Butylbenzylphthalate	8	7.4E-01	1E-03	7	3.3E+00	2E-05	1	1.0E-02	1E-03
	Isophorone	8	7.4E-01	1E-03	7	3.3E+00	2E-05	1	1.0E-02	1E-03
	Benzidine				4	4.5E+00	2E-03			
	Benzyl Alcohol	8	7.4E-01	7E-04	3	8.9E+00	4E-05	1	1.0E-02	1E-03
	Anthracene	8	7.4E-01	7E-04	7	3.3E+00	2E-05	1	1.0E-02	1E-03
	Phenol	8	7.4E-01	4E-04	7	3.2E+00	8E-06	1	1.0E-02	5E-04
	Benzoic Acid	8	3.6E+00	3E-04	3	4.3E+01	2E-05	1	5.0E-02	4E-04
	Diethylphthalate	8	7.4E-01	3E-04				1	1.0E-02	4E-04
	Dimethylphthalate	8	7.4E-01	2E-04	7	3.3E+00	5E-06	1	1.0E-02	3E-04

Appendix L

NONCONSERVATIVE SCREENING OF THE NONDETECTABLE CONTAMINANTS DATA BASE FOR CARCINOGENS AND NONCARCINOGENS

Table L1. Results of nonconservative screening for carcinogens where no samples were above detection limits (Concentrations are minimum detection limits)

Contaminant type	Contaminant	No. fish samples	Fish conc (mg/kg)	Carcinogen screen index fish ingest	No. sed samples	Sediment conc (mg/kg)	Carcinogen screen index sed ingest	No. water samples	Water conc (mg/L)	Carcinogen screen index water ingest
Inorganic	Beryllium	14	3.0E-03	4E-07				1	3.9E-03	5E-05
Organic	Acenaphthene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Acenaphthylene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Anthracene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Benzo(a)pyrene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Benzo(b)fluoranthene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Benzo(g,h,i)perylene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Benzo(k)fluoranthene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Chrysene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Dibenz(a,h)anthracene	8	5.4E-01	2E-04	7	9.2E-01	1E-06	1	1.0E-02	3E-04
	Fluoranthene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Fluorene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Indeno(1,2,3-cd)pyrene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Pyrene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Benzo(a)anthracene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Phenanthrene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	N-nitroso-di-n-propylamine	8	5.4E-01	1E-04	7	6.3E-01	6E-07		1.0E-02	
	Benzidine				4	3.2E+00	1E-04			
	Hexachlorobenzene	8	5.4E-01	3E-05	7	6.3E-01	2E-07	1	1.0E-02	5E-05
	Bis(2-chloroethyl)ether	8	5.4E-01	2E-05	7	6.3E-01	1E-07	1	1.0E-02	3E-05
	3,3'-Dichlorobenzidine	8	1.1E+00	1E-05	7	1.6E+00	1E-07	1	2.0E-02	3E-05
	2,4-Dinitrotoluene	8	5.4E-01	1E-05	7	6.3E-01	6E-08	1	1.0E-02	2E-05
	2,6-Dinitrotoluene	8	5.4E-01	1E-05	7	6.3E-01	6E-08	1	1.0E-02	2E-05
	Pentachlorophenol	8	2.7E+00	9E-06	3	4.5E+00	8E-08	1	5.0E-02	2E-05
	Aroclor-1254							1	1.0E-03	2E-05
	Aroclor-1260							1	1.0E-03	2E-05
	Aldrin	10	1.0E-02	5E-06	3	1.3E-02	3E-08	1	5.0E-05	2E-06
	Dieldrin				3	2.2E-02	5E-08	1	1.0E-04	5E-06
	N-nitrosodimethylamine				4	6.3E-01	5E-06			
	Hexachlorobutadiene	8	5.4E-01	1E-06	7	6.3E-01	7E-09	1	1.0E-02	2E-06
	Toxaphene				3	2.2E-01	3E-08	1	1.0E-03	3E-06
	Chlordane				3	1.1E-01	2E-08	1	5.0E-04	2E-06

Table L1 (continued)

Contaminant type	Contaminant	No. fish samples	Fish conc (mg/kg)	Carcinogen screen index fish ingest	No. sed samples	Sediment conc (mg/kg)	Carcinogen screen index sed ingest	No. water samples	Water conc (mg/L)	Carcinogen screen index water ingest
Organic	Heptachlor epoxide				3	1.3E-02	2E-08	1	5.0E-05	1E-06
	1,4-Dichlorobenzene	8	5.4E-01	4E-07	7	6.3E-01	2E-09	1	1.0E-02	7E-07
	Alpha-BHC				3	1.3E-02	1E-08	1	5.0E-05	9E-07
	Heptachlor				3	1.3E-02	8E-09	1	5.0E-05	6E-07
	Hexachloroethane	8	5.4E-01	2E-07	7	6.3E-01	1E-09	1	1.0E-02	4E-07
	2,4,6-Trichlorophenol	8	5.4E-01	2E-07	3	9.2E-01	1E-09	1	1.0E-02	3E-07
	Beta-BHC				3	1.3E-02	3E-09	1	5.0E-05	3E-07
	N-Nitrosodiphenylamine	8	5.4E-01	8E-08	7	6.3E-01	4E-10	1	1.0E-02	1E-07
	Bis(2-ethylhexyl)phthalate	8	5.4E-01	2E-07					1.0E-02	
	4,4'-DDE	10	1.0E-02	1E-07	3	2.2E-02	1E-09	1	1.0E-04	1E-07
	4,4'-DDT	10	1.0E-02	1E-07	3	2.2E-02	1E-09	1	1.0E-04	1E-07
	Gamma-BHC (Lindane)				3	1.3E-02	2E-09	1	5.0E-05	2E-07
	Isophorone	8	5.4E-01	6E-08	7	6.3E-01	4E-10	1	1.0E-02	1E-07
	1,2-Diphenylhydrazine				4	6.3E-01	7E-08			
	4,4'-DDD				3	2.2E-02	8E-10	1	1.0E-04	7E-08

Contaminant type	Contaminant	No. fish samples	Fish conc (mg/kg)	Carcinogen screen index fish ingest	No. sed samples	Sediment conc (mg/kg)	Carcinogen screen index sed ingest	No. water samples	Water conc (mg/L)	Carcinogen screen index water ingest	Carcinogen screen index sed ext exp
Radionuclide	U-235	8		3E-07							
	Co-60	8		6E-08							

Table L2. Results of nonconservative screening for noncarcinogens where no samples were above detection limits (Concentrations are minimum detection limits)

Contaminant type	Contaminant	No. fish samples	Fish conc (mg/kg)	Noncarcin screen index fish ingest	No. sed samples	Sediment conc (mg/kg)	Noncarcin screen index sed ingest	No. water samples	Water conc (mg/L)	Noncarcin screen index water ingest
Inorganic	Thallium	14	2.0E-02	8E-03	3	6.6E-01	1E-03	1	2.7E-03	1E-01
	Antimony	14	3.3E-01	2E-02	3	9.8E+00	4E-03	1	1.9E-03	1E-02
	Cadmium	14	1.3E-01	4E-03						
	Beryllium	14	3.0E-03	2E-05				1	3.9E-03	2E-03
	Silver	14	1.3E-01	1E-03				25	7.4E-04	7E-04
	Chromium	14	3.3E-01	2E-03						
	Selenium				3	1.0E-05	3E-10	1	9.7E-04	6E-04
	Nickel	14	3.3E-01	5E-04						
	Cyanide				4	1.0E+00	7E-06			
Organic	4,6-Dinitro-2-methylphenol	8	2.7E+00	8E-01	3	4.5E+00	6E-03		5.0E-02	
	2,4-Dinitrophenol	8	2.7E+00	4E-02	3	4.5E+00	3E-04	1	5.0E-02	7E-02
	Nitrobenzene	8	5.4E-01	3E-02	7	6.3E-01	2E-04	1	1.0E-02	6E-02
	Hexachlorobenzene	8	5.4E-01	2E-02	7	6.3E-01	1E-04	1	1.0E-02	4E-02
	Hexachloroethane	8	5.4E-01	2E-02	7	6.3E-01	9E-05	1	1.0E-02	3E-02
	1,2,4-Trichlorobenzene	8	5.4E-01	1E-02	7	6.3E-01	7E-05	1	1.0E-02	2E-02
	Chlordane				3	1.1E-01	3E-04	1	5.0E-04	2E-02
	Hexachlorobutadiene	8	5.4E-01	8E-03	7	6.3E-01	5E-05	1	1.0E-02	1E-02
	2,4-Dichlorophenol	8	5.4E-01	5E-03	3	9.2E-01	4E-05	1	1.0E-02	1E-02
	Aldrin	10	1.0E-02	1E-02	3	1.3E-02	6E-05	1	5.0E-05	5E-03
	Heptachlor epoxide				3	1.3E-02	1E-04	1	5.0E-05	1E-02
	4-Chloroaniline	8	5.4E-01	4E-03	3	9.2E-01	3E-05	1	1.0E-02	7E-03
	Naphthalene	8	5.4E-01	4E-03	7	6.3E-01	2E-05	1	1.0E-02	7E-03
	2-Chlorophenol	8	5.4E-01	3E-03	3	9.2E-01	3E-05	1	1.0E-02	6E-03
	Pentachlorophenol	8	2.7E+00	3E-03	3	4.5E+00	2E-05	1	5.0E-02	5E-03
	Hexachlorocyclopentadiene	8	5.4E-01	2E-03	7	6.3E-01	1E-05	1	1.0E-02	4E-03
	Dieldrin				3	2.2E-02	6E-05	1	1.0E-04	6E-03
	Endosulfan II				3	2.2E-02	6E-05	1	1.0E-04	6E-03
	Dibenzofuran	8	5.4E-01	2E-03	3	9.2E-01	1E-05	1	1.0E-02	3E-03
	Endosulfan I				3	1.3E-02	4E-05	1	5.0E-05	3E-03
	2,4-Dimethylphenol	8	5.4E-01	8E-04	3	9.2E-01	7E-06	1	1.0E-02	1E-03
	2,4,5-Trichlorophenol	8	2.7E+00	8E-04	3	4.5E+00	6E-06	1	5.0E-02	1E-03
	Pyrene	8	5.4E-01	5E-04	7	6.3E-01	3E-06	1	1.0E-02	1E-03

Table L2 (continued)

Contaminant type	Contaminant	No. fish samples	Fish conc (mg/kg)	Noncarcin screen index fish ingest	No. sed samples	Sediment conc (mg/kg)	Noncarcin screen index sed ingest	No. water samples	Water conc (mg/L)	Noncarcin screen index water ingest
Organic	4,4'-DDT	10	1.0E-02	6E-04	3	2.2E-02	6E-06	1	1.0E-04	6E-04
	Fluoranthene	8	5.4E-01	4E-04	7	6.3E-01	2E-06	1	1.0E-02	7E-04
	Fluorene	8	5.4E-01	4E-04	7	6.3E-01	2E-06	1	1.0E-02	7E-04
	Endrin				3	2.2E-02	1E-05	1	1.0E-04	1E-03
	2-Methylphenol	8	5.4E-01	3E-04	3	9.2E-01	3E-06	1	1.0E-02	6E-04
	4-Methylphenol	8	5.4E-01	3E-04	3	9.2E-01	3E-06	1	1.0E-02	6E-04
	Bis(2-ethylhexyl)phthalate	8	5.4E-01	8E-04					1.0E-02	
	Acenaphthene	8	5.4E-01	3E-04	7	6.3E-01	2E-06	1	1.0E-02	5E-04
	1,2-Dichlorobenzene	8	5.4E-01	2E-04	7	6.3E-01	1E-06	1	1.0E-02	3E-04
	Gamma-BHC (Lindane)				3	1.3E-02	6E-06	1	5.0E-05	5E-04
	Di-n-butylphthalate	8	5.4E-01	2E-04	7	6.3E-01	9E-07	1	1.0E-02	3E-04
	Bis(2-chloroisopropyl)ether	8	5.4E-01	4E-04	7	6.3E-01	2E-06		1.0E-02	
	Heptachlor				3	1.3E-02	4E-06	1	5.0E-05	3E-04
	Methoxychlor				3	1.1E-01	3E-06	1	5.0E-04	3E-04
	Butylbenzylphthalate	8	5.4E-01	8E-05	7	6.3E-01	5E-07	1	1.0E-02	1E-04
	Isophorone	8	5.4E-01	8E-05	7	6.3E-01	5E-07	1	1.0E-02	1E-04
	Benzidine				4	3.2E+00	2E-04			
	Benzyl Alcohol	8	5.4E-01	5E-05	3	9.2E-01	4E-07	1	1.0E-02	1E-04
	Anthracene	8	5.4E-01	5E-05	7	6.3E-01	3E-07	1	1.0E-02	1E-04
	Phenol	8	5.4E-01	3E-05	7	4.0E-01	1E-07	1	1.0E-02	5E-05
	Benzoic Acid	8	2.7E+00	2E-05	3	4.5E+00	2E-07	1	5.0E-02	4E-05
	Diethylphthalate	8	5.4E-01	2E-05				1	1.0E-02	4E-05
	Dimethylphthalate	8	5.4E-01	2E-05	7	6.3E-01	9E-08	1	1.0E-02	3E-05

Appendix M

CLASSIFICATION OF SEDIMENT WASTE FROM WHITE OAK CREEK EMBAYMENT BY TOXICITY CHARACTERISTIC LEACHATE PROCEDURE

INTRODUCTION

Waste management concerns associated with construction of the White Oak Creek Embayment (WOCE) sediment-retention structure have focused on radiological contaminants; however, WOCE sediment also contains elevated levels of inorganic contaminants (Tables C1 and C2). Based on the concentrations of the contaminants present in the sediment, there is a potential for waste generated from the sediment to be classified as mixed waste. Such a classification would greatly increase the effort necessary to manage the waste created by the construction of the retention structure. Therefore, sediment from the embayment was subjected to a Toxicity Characteristic Leachate Procedure (TCLP) to determine whether the sediment should be classified as mixed waste. The TCLP is required by the U. S. Environmental Protection Agency (EPA) for the classification of waste (Sect. V of 40 *CFR* Parts 261, 264, 265, 268, 271, and 302; *Federal Register* Vol. 55, No. 61, March 29, 1990, pp. 11846). A discussion of the TCLP, including methods, regulated constituents and regulatory levels, is given in *Federal Register*, Vol. 55, No. 61, March 29, 1990, pp. 11798-11877.

METHODS

Prior to performing the TCLP, samples were screened by comparing the levels of inorganic or organic contaminants detected by conventional analyses (atomic absorption plus inductively coupled plasma for inorganic and gas chromatograph plus gas chromatograph/MS for organic analytes) with guidance values. If the concentrations in dried sediment were above or close to the guidance level, the TCLP was performed on the material. The location of sites in the embayment from which samples were collected to perform the TCLP are shown in Fig. M1.

RESULTS

Results from conventional analytical methods from samples taken in the same area of lower WOCE as the TCLP samples indicate that the maximum concentration for mercury (27.4 μg/g dry sediment) from a depth of 8 to 12 cm, was above the TCLP guidance level but well below any level of concern for human health (Tables C1 and C2). Four other inorganics (cadmium at 2.8 μg/g) (Tables C1 and C2) had maximum concentrations that were within 10% of the TCLP guidance levels at a depth of 4 to 8 cm, which corresponds to ^{137}Cs peak values. TCLP results for arsenic and mercury in samples collected April 1, 1991, had at least one value greater than 10% of the guidance value; however, none of the TCLP results for inorganics approached the guidance values (Table M1). No trends in concentrations of inorganics were detected which could be associated with changes in ^{137}Cs concentrations or with sediment depth. Because all values obtained from the TCLP were below guidance values, any sediment waste generated by the construction of the retention structure should not be classified as mixed waste.

Table M1. Comparison of TCLP values for WOCE sediments with regulatory guidlines for solid materials and QC information (01Apr91 data only). Units for all values are µg/g dry sediment.

Collection depth, date, id#	Ag	As	Ba	Cd	Cr	Hg	Ni	Pb	Se	Tl
TCLP Guidelines[a]:	100	100	2000	20	100	4	N/A[b]	100	20	N/A[b]
8-16 cm, 27Sep90, 42703L	0.21	0.04[c]	35	1.3	3.8	0.02[d]	2.7	16	0.11	26
0-0.5 ft, 16Nov90, D4-1L	0.23	0.04[c]	31	0.5	0.01[c]	0.02[d]	1.1	8.7	0.11	21
0-0.5 ft, 16Nov90, D5-1L	0.24	0.04[c]	43	0.58	0.31	0.02[d]	1.2	13	0.11	20
0-0.5 ft, 16Nov90, D6-1L	0.11	0.04[c]	32	0.17	0.01[c]	0.02[d]	0.62	4.5	0.11	39
0-24 cm, 12Dec90, 54201L	0.21	0.04[c]	28	0.34	0.01[c]	0.02[d]	1.1	7.2	0.11	24
0-10 cm, 01Apr91, 59300L	1.2	17	0.04[e]	0.11	0.07[c]	0.30	0.93	4.3	0.4	16
0-23 cm, 01Apr91, 59400L	1.3	26	0.04[e]	0.47	0.07[c]	0.03	1.6	11	0.4	16
0-12 cm, 01Apr91, 59500L	1.2	21	0.04[e]	0.16	0.07[c]	0.16	1.1	6.4	0.4	40
10-18 cm, 01Apr91, 59600L	1.2	24	0.04[e]	0.46	0.07[c]	0.74	1.6	9.3	0.4	32
QC: NIST 2 ppm, 01Apr91	---[c]	2.44	2.19	2.06	2.06	1.47	2.11	2.14	2.42	2.18
QC: NIST 1 ppm, 01Apr91	1.1	1.32	1.08	1.03	1.02	---[c]	1.05	1.10	1.25	1.14
QC: IN HOUSE, 2Q90, 01Apr91	---[c]	1.38	41.3	0.70	1.27	0.06	---[c]	2.21	---[c]	---[c]
QC: ACTUAL VALUES, 2Q90, 01Apr91	---[c]	1.0	38.0	0.6	1.2	0.04	---[c]	2.0	0.3	---[c]
QC: BLANK, 01APR91	0.02[c]	0.86	56.0	0.01	0.01[c]	0.02[c]	0.01	0.17	0.02[c]	0.19
100-106 cm, 27Sep90, 42726L	0.015	0.05[c]	3	0.006	0.035	0.1[d]	---[c]	0.05[c]	0.085	---[c]
10-11 ft, 16Nov90, D5-6L	0.007	0.05[c]	2.4	0.05[c]	0.036	0.1[d]	---[c]	0.05[c]	0.05[c]	---[c]

Table M1 (continued)

Collection depth, date, id#	Ag	As	Ba	Cd	Cr	Hg	Ni	Pb	Se	Tl
TCLP Guidelines[a]:	100	100	2000	20	100	4	N/A[b]	100	20	N/A[b]
1.5-2 ft, 16Nov90, D6-2L	0.005[c]	0.05[c]	2.2	0.05[c]	0.019	0.1[d]	---[c]	0.05[c]	0.05[c]	---[c]
104-108 cm, 12Dec90, 54227L	0.012	0.05[c]	1.6	0.06	0.032	0.1[d]	---[c]	0.05[c]	0.05[c]	---[c]
128-132 cm, 12Dec90, 54233L	0.011	0.05[c]	3.8	0.07	0.022	0.1[d]	---[c]	0.05[c]	0.05[c]	---[c]

[a] Values equal to guidance levels for solutions multiplied by 20 (convert to solids).
[b] TCLP reference values for these elements were not included in the Federal Register, March 29, 1990, pp 11798-11877.
[c] Value less than the detection limit, or missing.
[d] Mercury holding times violated for all samples collected prior to April 1. Value is less than the detection limit.
[e] Value less than the detection limit after correction for barium blank. Worldwide mean value for total barium in sediments approximately 460 µg/g (Environmental Chemistry of the Elements, Bowen, 1979).

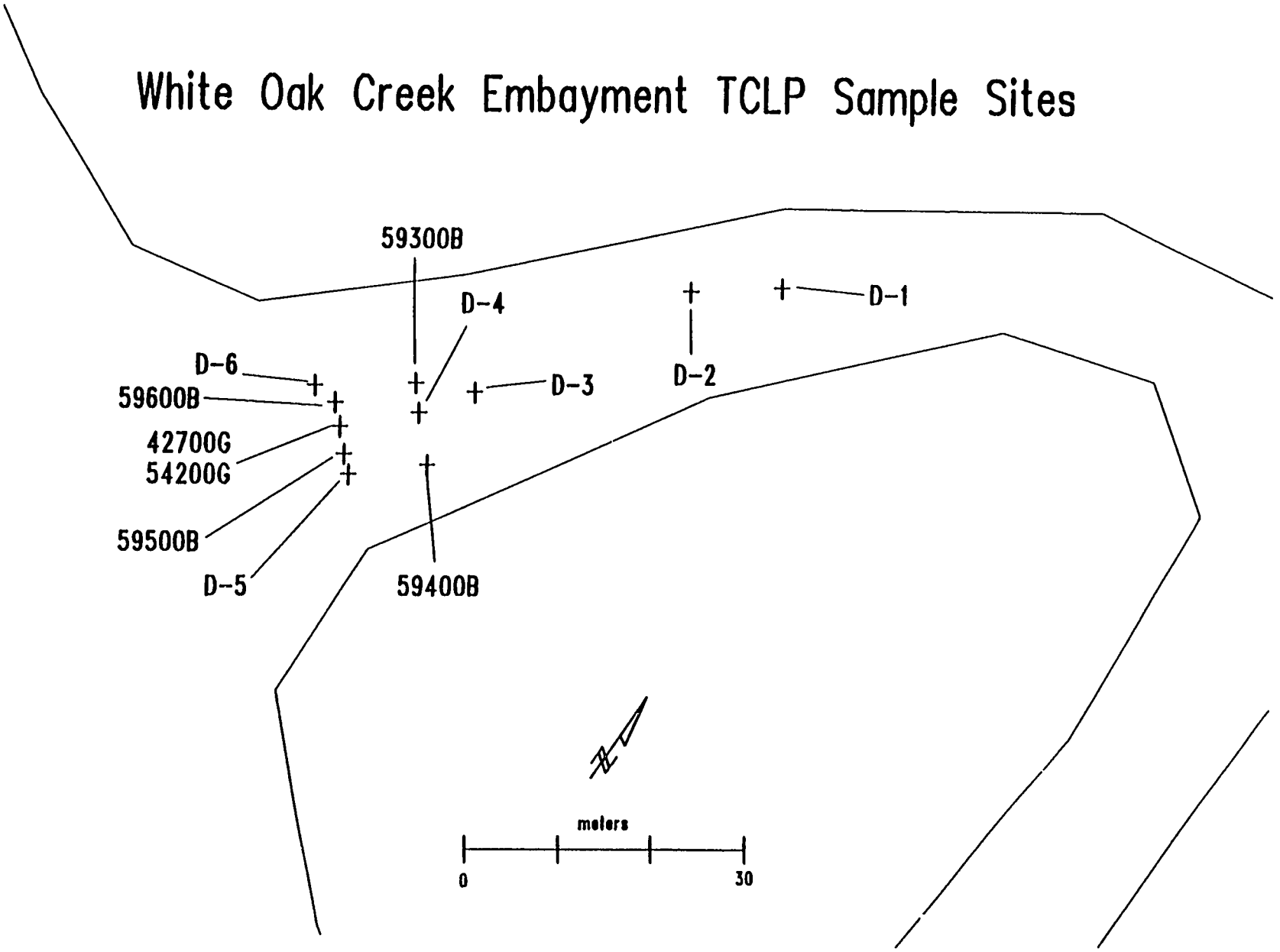

Fig. M1. Locations of core sampling sites near the mouth of WOCE from which samples were collected and screened for inorganic contaminants before subjecting them to the Toxicity Characteristic Leachate Procedure to determine the waste classification of the sediment.

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